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Constrained Facet Analysis-- A New Method for Evaluating Local Frontiers of Efficiency and Performance

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Abstract

Methods that help commanders and managers evaluate military capability and efficiency are vitally important to the Department of Defense (DOD) and the military services. This paper discusses a new approach that supports managers in detecting sources of inefficiency, pinpointing relevant factors for correcting these inefficiencies, and identifying opportunities for improving operational effectiveness. An example involving the operation of tactical fighter wings is presented to illustrate the use of the method in planning for more efficient operations.

Introduction

The public expects military efficiency from the combat forces it supports. As a result, decision makers in the Department of Defense (DOD) are investigating better ways to evaluate military capability and efficiency. These improved methods will help commanders and managers detect sources of inefficiency, direct attention to the relevant factors for correcting these inefficiencies, and reveal other opportunities for improving operational effectiveness. Specifically, this study offers another approach and there are four basic questions which motivate it:

(1) What level of military capability can the services achieve with resources available?

(2) What capability is required and what shortfalls exist?

(3) What resource acquisitions or redistributions are needed to gain maximum improvement in efficiency and effectiveness?

(4) How can management systems be changed to improve the identification and correction of factors which limit the readiness of our military?

For several years, military analysts have been searching for integrative models of efficiency and capability--models which will aid in the detection and diagnosis of operational problems as well as assist in budgeting and other forms of planning. However, no fully satisfactory method has been found. To address the four questions mentioned, management planning models need productivity estimates based on observations from efficient operations. Furthermore, since mathematical models of complex military processes are difficult to specify, the Air Force must rely on relative measures of performance derived from empirical data.

Many of the analytical techniques currently used by the Air Force, such as ratio analysis, do not require *a priori* specification, but do require the use of partial measures of performance which cannot take into account interactions and trade-offs over the full range of inputs and outputs of a given military process. Regression, also commonly used by the Air Force, is equally uninformative for frontier estimation purposes because both efficient and inefficient observations influence the parameters of the regression equation.

Because of those limitations of ratio analysis and regression, the efficiency measurement concepts of Farrell,[1] which were later extended by Charnes, Cooper, and Rhodes,[2] were viewed as major breakthroughs in the development of efficiency models for not-for-profit enterprises. The Charnes, Cooper, and Rhodes theory and methodology, *Data Envelopment Analysis (DEA),* was also an effective tool for classifying organizations into efficient and inefficient sets, but was limited in its ability to provide planning information. As a result of intensive work on this problem at the University of Texas during the last four years, a new method of computing efficiency, *Constrained Facet Analysis (CFA),* has been developed by Clark and is the central focus of this paper.[3] The CFA approach has been tested by Bessent and Bessent through field experience with a network of school unit managers.[4] A brief account of the development follows.

Early Work on Multiple Output, Multiple Input Efficiency Measurement

Farrell first proposed a method in which multiple outputs and inputs could be used to locate an "efficiency frontier" made up of units which were achieving the greatest amount of combined (empirically weighted) outputs for the combined inputs employed.[5] Later, Farrell's concept was made operational by Charnes, Cooper, and Rhodes who proposed the linear programming model solution, DEA.[6] Computer software for the efficient solution of the model was developed by Ali, Bessent, Bessent, and Kennington, and field applications were begun in 1980 to test the procedure under actual operating conditions.[7] By 1982, the experience gained in the employment of the DEA method and the results of experiments constructed for sensitivity testing led to identification of several limitations in the DEA model.[8]

Extensions to Efficiency Analysis for Improved Management Information

Managers of inefficient units needed to identify other operating units which had resource levels and mixes similar to their own, but which had higher outputs. This led to the development of interactive computer software which enabled the manager to locate units which are more efficient but which are otherwise similar. These more efficient units and their input and output levels are identified and displayed in rank order of similarity for on-line inspection by managers.

In a recent development, the use of efficiency analysis was extended to areas of planning and resource allocation through the new CFA iterative approach proposed by Bessent, Bessent, Clark, and Elam based on new theory and models.[9]

As shown in the Appendix, the CFA model first identifies an efficiency frontier made up of operational units which achieve the highest level of output for their given levels of input. Then, an inefficient unit is compared to other units on the frontier to determine its degree of inefficiency. For such inefficiency measurement to be meaningful, it is crucial to determine the appropriate comparison units on the frontier (the "proper facet"). At the final iteration, the CFA model locates the proper facet made up of observed units with similar mixes of inputs and outputs.

Current Work on Decision Support System

Decision Support System (DSS) work has already begun. Software for the CFA is currently under development. Additional software under development will enable interactive data base manipulation and modeling.[10] These new computer capabilities, together with the aforementioned model extensions, form the basis for the prototype DSS which includes:

(1) Automated data collection, verification, and updating.
(2) Linkages between assessment periods and related subunits.
(3) Routines for multiple data configurations.

The DSS will support the following decision-related activities:

(1) Constrained Facet Analysis.
(2) Search for similar, but efficient units.
(3) Statistical analysis.
(4) Preparation of managerial reports.

Experience gained from the prototype system will enable managers, analysts, and researchers to make use of efficiency frontier estimation in industries which previously have been unsuitable for application of efficiency models. Based on initial trials, **we are confident that the evolution of this DSS will be accompanied by more effective management decision making and better control of organizational operations.** Furthermore, efficiency analysts and researchers need a DSS for organizational modeling and analyses. Such capabilities would lead to greater understanding of the production process, enabling the development of plans to effect technological changes or resource reallocations which improve the collective efficiency and output levels of organizational entities. The CFA and its potential for use in areas of decision support, resource allocation, and goal setting are worthwhile directions for research. The research outcomes would be of considerable value to agencies throughout the public sector.

Use of CFA for Decision Support

The primary purpose of this section is to present a limited numerical example to show the complexity of planning for more efficient operations and to illustrate the use of CFA. The input and output measures are similar to those used by Air Force decision makers and were chosen to highlight the key objectives, operating characteristics, and input factors of operational wings. Some of the data are fictitious and were generated for purely illustrative purposes.

Output and Input Data

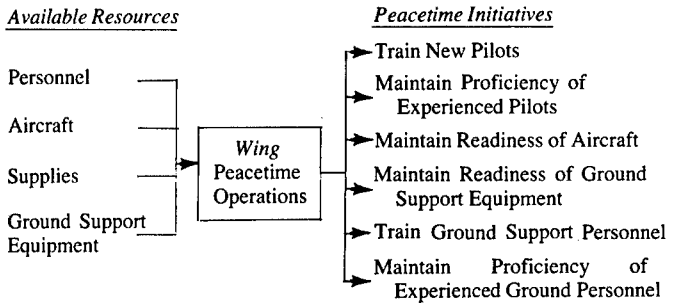
	Outputs			Inputs						
Wings	1 Net Combat Practice Sorties (Annually)	2 Flight Training Sorties (Annually)	3 Mission Capable Aircraft Days (Annually)	4 Daily Average Available Aircraft (During the Year)	5 Supply Support Factor (Annual Average)	6 Available Labor Hours (Annually) (x 1000)	7 Mission Essential Equipment Availability (Days During the Year)	8 Efficient Wings in Facet	9 Efficiency Measures upper bound	9 Efficiency Measures lower bound
A	15,192	0*	15,794	72	6.1	1,980	81,000	A	1.00	1.00
B	10,435	0	10,083	45	17.3	1,408	55,000	A,D,J,N	.95	.72
C	13,991	0	14,552	69	26	1,936	80,625	A,D,I,J,G	.87	.81
D	12,348	0	13,771	51	13	1,496	55,375	D	1.00	1.00
E	0	17,193	21,667	84	17.3	2,508	100,000	E	1.00	1.00
F	0	9,741	12,795	52	10.4	1,320	57,500	F	1.00	1.00
G	3,341	9,148	16,848	64	25.9	1,302	75,000	G	1.00	1.00
H	6,673	0	10,178	33	26	924	37,125	H	1.00	1.00
I	16,010	0	16,196	72	13	1,980	79,800	I	1.00	1.00
J	0	19,661	22,297	98	8	2,640	110,250	J	1.00	1.00
K	0	4,640	4,562	22	103.7	740	26,750	D,E,F,J,N,G	.87	.28
L	2,511	5,021	10,817	70	25.9	1,188	83,400	D,H,F,N,G	.70	.60
M	2,682	6,147	13,012	80	6.9	1,179	90,000	M	1.00	1.00
N	0	33,257	29,760	112	34.5	4,400	126,000	N	1.00	1.00

*Constrained facet analysis will not allow zero amounts in inputs or outputs. Thus, relative small values between 1 and 10 were substituted for 0 in several trials. The same results were obtained in each trial implying that any amount less than 10 is sufficiently small relative to the observed positive sortie amounts and can be used as an acceptable approximation of 0.

Table 1.

Selection of Input and Output Measures and Data Used

The input and output measures used in this analysis are based upon the typical wing function as follows:



Data were generated for 14 fictitious tactical fighter wings, 8 of which (A through H) are assumed to be organized under one intermediate headquarters and the remaining 6 (I through N) under another (see Table 1). Both intermediate headquarters are assumed to report to the Tactical Air Command Headquarters. Wings are assumed to fall into one of three mission categories: combat operations, aircraft familiarization (training), or both. Furthermore, each wing is assumed to have one assigned aircraft type, which can be further classified by age and complexity.

The particular input and output measures selected for use in this example are defined as follows:

Outputs:

Output 1: Net Combat-Practice Sorties Flown. A single sortie involves the departure, flight, and full-stop landing (not touch-and-go) of one fighter aircraft. When the aircraft lands, ground operations begin to return the aircraft to mission capable status and prepare for the next sortie.

The number of sorties flown can be viewed as a surrogate measure of wing output related to training aircrews and exercising ground support functions to maintain high levels of personnel readiness and to keep mission essential equipment in good operating condition.

One category of sorties, labeled "net combat-practice," is defined as those sorties flown by fully qualified pilots to maintain proficiency in combat tactics. This category *excludes* sorties flown in training new pilots and those resulting in aborts. The Output 1 data for each of the 14 wings (A,B,C,...,N) are shown in the first column of Table 1.

Output 2: Flight Training Sorties. This measures the degree to which a wing is active in training pilots. The annual requirements for training sorties are established by operations and tracked by analysts. Annual training sorties for each of the hypothetical wings in this example are shown in the second column of Table 1.

Output 3: Mission Capable Aircraft Days. An aircraft can be not mission capable for supply reasons only (NMCS), for maintenance reasons only (NMCM), or both (NMCB). Thus, let there be j = 1,2,...,n aircraft. The percent of time that the jth aircraft is mission capable during the year is:

$$\%\ MC_j = 100 - (\%\ NMCM_j) - (\%\ NMCS_j) - (\%\ NMCB_j)$$

Let T_j be the total number of days the jth aircraft is on hand at the unit and let $T = \sum_j T_j$ be the total available aircraft days at the unit. Then the total number of annual mission capable aircraft days (MCAD) is:

$$MCAD = \sum_j MCAD_j = \sum_j T_j\ [\%\ MC_j]$$
$$= \sum_j T_j\ [100 - (\%\ NMCM_j) - (\%\ NMCS_j) - (\%\ NMCB_j)]$$

The Output 3 data used are shown in Table 1.

Inputs:

Input 1: Average Available Aircraft. The average number of aircraft on hand during the period can be computed by dividing the sum of not mission capable days and mission capable days by the number of days in the period:

Not Mission Capable Aircraft Days	10,486
Mission Capable Aircraft Days	+ 15,794
Total Aircraft Days	26,280
Days in Period	÷ 365
Average Daily Aircraft Available	72

Values for each wing are shown in Table 1, column 4.

Input 2: Supply Support Factor. Two important considerations in assessing supply support of wing flight operations are:

(a) Were mission essential parts available and provided upon request?

(b) If mission essential parts were not available, how long did mechanics have to wait for these parts?

The fewer parts that are available or the longer one has to wait, the lower the supply support.

Suppose there are j = 1,2,...,n mission essential parts. Let D_j = the demand for the jth mission essential part during the year being considered. Let R_j be the average length of time from request to receipt of the jth part. Then the weighted (weighted by demand) average number of hours awaiting delivery of a single mission essential part would be:

$$\left(\sum_j D_j R_j\right) \div \left(\sum_j D_j\right)$$

This measures supply *non*-support; thus, the measure of supply support should have a reciprocal relation to this sum, perhaps $\left(\sum_j D_j / \sum_j D_j R_j\right)$. Supply support factors for this example were arbitrarily assigned as shown in Table 1, column 5.

Input 3: Available Labor Hours (in thousands of hours). This measures the size of the available work force which generally varies proportionately with the levels of flying and ground support activities at each wing. See Table 1 for the values used in the example.

Input 4: Mission Essential Equipment Availability. Ground equipment authorizations are determined at management levels above the wing, but wing level managers have some control over the proportion of assigned equipment which is serviceable at any one time. Higher levels of availability and serviceability of wing mission essential equipment should provide smoother, more efficient flying and maintenance operations, resulting in greater output. Levels of ground equipment authorizations also vary proportionately with levels of flying and required ground support activities, but wings seldom have equipment levels equal to authorizations. One measure might be $\sum_j A_j$, where A_j is the amount of time in days that the jth piece of mission essential equipment is assigned to the wing. This measure does not reflect the difference in value of individual equipment types; e.g., a power cart used in starting aircraft might be more valuable to the operations than a tow bar. See Table 1 for the arbitrarily assigned values used in this example to represent cumulative days of mission essential equipment availability.

Results of CFA

The CFA was performed for all wings, resulting in the identification of inefficient wings B, C, K, and L. In this section, the overall results of the evaluation have been presented in Table 1, columns 8 and 9. Limited space does not allow a detailed discussion for each inefficient wing; however, the more detailed information obtainable from the analysis has been provided (Tables 2 and 3) for wing K only.

Range Between Upper and Lower Bounds of Efficiency Indicates "Outlier" Status of Wings

Wing K is of particular interest because, in forming wing K's proper facet (Table 1, column 8), the efficiency measure decreased from an upper bound .87 to the lower bound amount of .28 as shown in Table 1, column 9. It can be shown that the range between the upper and lower bounds of efficiency corresponds to the degree to which wing K observed values are outlier values. Therefore, wing K observations should receive special attention in any follow-up analysis by management because the frontier facet used in evaluating the efficiency of wing K is formed by observations which differ significantly from wing K's observations in terms of levels and mixes of observed input and output amounts. To illustrate, the adjusted output values imply the following rates if efficient:

$$\text{Sortie rate if efficient} = \frac{(1/.28)\ (4640)}{(12)(22)} = 62.75$$

$$\text{Mission capable rate if efficient} = \frac{(1/.28)\ (4562)}{(365)(22)} = 202.8\%$$

Clearly, these rates, if efficient, are unattainable. It is highly unlikely that aircraft which have been flying at a sortie rate of 17.5 could sustain a sortie rate of 62.75, and it is impossible to achieve a mission capable rate greater than 100%. Thus, the .28 lower bound efficiency measure is inappropriate for computing values if efficient.

However, the comparison of wing K with frontier units shown in Table 2 suggests that the .87 upper bound efficiency value is likewise inappropriate. The data in Table 2 were obtained by dividing all input and output observed values of each wing in the table by that wing's observed value of daily average available aircraft, which in effect scales the wing observations to facilitate comparison. The data relationships in Table 2 indicate that wing K is indeed an outlier and that the upper bound of .87 is an overestimation of its efficiency.

The wing K amounts in Table 2, columns 3, 5, 6, and 7, are outliers in the sense that they are extreme or nearly extreme when compared to the ranges of values for frontier units. The wing K value for the average number of mission capable aircraft days per aircraft (column 3) is *lower* than all the other values associated with efficient wings in column 3. The supply support factor per aircraft for wing K is substantially *higher* than any of the other values in column 5. Similarly, the amount of labor hours per aircraft available to wing K during the year was the *second largest* amount in column 6; and wing K's availability of mission essential equipment per aircraft was the *largest* amount in column 7.

In short, wing K performed poorly in achieving a mission capable rate that was too low relative to frontier units, while its

Wing K Observed Values Per Aircraft Compared With the Observed and Average Values Per Aircraft of Efficient Wings

	1 Wings	2 Average Sorties Flown Per Aircraft (Annually)*	3 Mission Capable Aircraft Days Per Aircraft (Annually)	4 Daily Average Available Aircraft Per Aircraft (Annually)	5 Supply Support Factor Per Aircraft (Annually)	6 Available Labor Hours (x 1000) Per Aircraft (Annually)	7 Mission Essential Equipment Availability Per Aircraft (Annually)
Efficient Wings Defining Wing K's Facet	D	242.12	270.02	1.00	.25	29.33	1085.78
	E	204.68	257.94	1.00	.21	29.86	1190.48
	F	187.33	246.06	1.00	.20	25.38	1105.77
	G	196.55	263.25	1.00	.40	20.34	1171.88
	J	200.62	227.52	1.00	.08	26.94	1125.00
	N	296.94	265.71	1.00	.31	39.29	1125.00
Other Efficient Wings On the Frontier	A	211.00	219.36	1.00	.08	27.50	1125.00
	H	202.21	308.42	1.00	.79	28.00	1125.00
	I	222.36	224.94	1.00	.18	27.50	1108.33
	M	110.37	162.65	1.00	.09	14.74	1125.00
Averages for Wings Defining Facet		221.37	255.08	1.00	.24	28.52	1133.99
Averages For All Efficient Wings		207.42	244.59	1.00	.26	26.89	1128.77
Wing K's Observed Values (Per Aircraft)		210.91	207.36	1.00	4.71	33.64	1215.91

*Average Sorties Flown Per Aircraft During the Year = $\left[\left(\frac{\text{Annual Combat - Practice}}{\text{Sorties Flown}}\right) + \left(\frac{\text{Annual Training}}{\text{Sorties Flown}}\right)\right] \div \left(\frac{\text{Average Daily Aircraft Available During The}}{\text{Year}}\right)$

Table 2.

Marginal Rates of Substitution and Marginal Rates of Productivity in the Proper Facet of Wing K

	1. Δy_1 (multiplier = .0000146) (Combat-Practice Sorties)	2. Δy_2 (multiplier = .0000191) (Flight Training Sorties)	3. Δy_3 (multiplier = .0000423) (Mission Capable Aircraft Days)	4. Δx_1 (multiplier = .0074578) (Average Available Aircraft)	5. Δx_2 (multiplier = .0067169) (Supply Support Factor)	6. Δx_3 (multiplier = .0001566) (Available Labor Hours)	7. Δx_4 (multiplier = .0000011) (Mission Essential Equipment Availability)
1. Δy_1 (multiplier = .0000146)		− 0.76398	− 0.34515	0.00196	0.00217	0.09323	13.27273
2. Δy_2 (multiplier = .0000191)	− 1.30822*		− 0.45154	0.00256	0.00284	0.12197	17.36364
3. Δy_3 (multiplier = .0000423)	− 2.89726	− 2.21466		0.00567	0.00630	0.27011	38.45455
4. Δx_1 (multiplier = .0074578)	510.80822	390.46073	176.30733		− 1.11030	− 47.62324	− 6,779.81818
5. Δx_2 (multiplier = .0067169)	460.06164	351.67016	158.79196	− 0.90065		− 42.89208	− 6,106.27273
6. Δx_3 (multiplier = .0001566)	10.72603	8.19895	3.70213	− 0.02100	− 0.02331		− 142.36364
7. Δx_4 (multiplier = .0000011)	0.07534	0.05759	0.02600	− 0.00015	− 0.00016	− 0.00702	

*Note: The number shown in column 1 and row j is the marginal change in the column variable with respect to one unit change in the row variable; e.g., the number in column 1, row 2, is:

$$\frac{\Delta y_1}{\Delta y_2} = -\frac{\text{row 2 multiplier}}{\text{col 1 multiplier}} = -\frac{.0000191}{.0000146} = -1.3082$$

Table 3.

input amounts for equipment, labor, and supplies are too high. Furthermore, the mix of inputs at wing K is quite different from other wings because of its extremely high outlier value for supply support.

Perhaps after closer inspection of wing K, knowledgeable managers could subjectively estimate the degree of wing K's inefficiency, which might enable the development of a "phantom" frontier unit for inclusion in the neighborhood or facet of wing K. This artificial unit could be given the same mix of inputs as wing K or a different mix if equipment and supplies need to be transferred. The inclusion of this artificial, phantom frontier unit in the facet of wing K should be constructed so it produces an efficiency measure for wing K which is equal to the subjective estimate provided by managers.

In summary, a large difference between the upper and lower bounds of efficiency for any given wing implies that a closer inspection of this outlier wing is needed before conclusions can be drawn about its actual degree of inefficiency.

On the other hand, for some inefficient wings like C and L, the difference between the upper and lower bound measures is relatively small (Table 1); i.e., these wings have mixes of inputs and outputs which are more like nearby frontier facets. In such cases, the upper and lower bound measures provide better estimates of the actual degrees of inefficiency.

Marginal Rates of Substitution and Productivity

The marginal rates of substitution and productivity obtained from the CFA method provide information about the frontier that is valuable even when analyzing outlier units like K. These rates are useful and informative because they are derived from the nearest set of *empirical* observations. Table 3 presents marginal rates of substitution and productivity for the facet associated with wing K.

The negative values in Table 3 are the marginal rates of substitution, and the positive values are the marginal rates of productivity. For example, the value −1.30822 in Table 3, column 1, row 2, indicates the marginal rate of substitution between combat-practice sorties (y_1) and training sorties (y_2). Thus, if unit K is operating efficiently, an increase of 10 training sorties would require a decrease of approximately 10 × (1.30822) = 13 combat-practice sorties, provided all other input and output amounts remain constant.

For wings B, C, and K, the marginal rates of substitution of combat-practice sorties with respect to training sorties were all nearly equal to one in their respective facets. The trade-off appears to be realistic since the sorties values used in this example were actual amounts flown by real tactical fighter wings. The amounts used were obtained from an FY81 Tactical Air Command report.[11] If all other input and output values remain constant and if a wing is operating at peak efficiency, then one would expect that an increase of 10 training sorties would require a reduction of about 10 combat-practice sorties, since training sorties and combat-practice sorties require nearly the same amount of resources.

Furthermore, the data in Table 3, columns 1, 2, and 3, row 4, provide the marginal values of one additional aircraft (Δx_1 = 1) in increasing each of the outputs; e.g., if wing K gains one additional aircraft, then to remain on the frontier, the wing should produce about 511 additional combat-practice sorties during the next year, provided of course that all other inputs and outputs remain unchanged. The remaining data in Table 3 could be used in similar fashion to evaluate the impact of other changes in input and output amounts.

Conclusions and Directions for Further Research

This program of research and development was undertaken to obtain a comprehensive, integrated theory and methodology which would not only identify sources of inefficient operations but also provide information to managers for improving the efficiency of their organizations. A further goal was to develop

interactive, user friendly software so managers could assess and increase productivity in those organizations for which they are responsible. In this paper, the potential usefulness of the theory and methodology was presented through an example.

It can be seen from this exploratory analysis that research can now be undertaken for capability assessment using real Air Force units and actual measurements of performance. In short, answers to the four basic questions (Introduction) which motivated the study are now within reach:

(1) If the efficiency analysis of Air Force wings were to be conducted, expected outputs could be determined which would show what capability would be achieved if all wings were as efficient as the best.

(2) A comparison of the sorties generated, for example, with the number of sorties that could be expected if inefficiencies were removed, would provide management information which could enable wing commanders to move toward full capability. If results for all wings included in the exploratory analysis had been shown, it could be noted, for example, that the four inefficient fictitious wings would need to generate at least 8,688 additional sorties per year to attain overall efficient operations with existing resources.

(3) Note that our new model solution provides estimates of efficient marginal rates of substitution and productivity. Thus resource planning could be based on optimal distributions to achieve maximum outputs. A pilot test is underway which will optimize the flow of resources over a network to achieve specific effectiveness goals.[12]

(4) This, of course, will require extended experience with the method in actual field operations. A project should be undertaken to get management involved in field testing and continued development. The DSS, for example, should be based on the needs of operational personnel as determined by their hands-on experience.

APPENDIX

Model Used in Constrained Facet Analysis (CFA)
of Not-Fully-Enveloped Units

The CFA model used in the iterative method is presented in this Appendix. It can be used in evaluating the range of inefficiency in organizational units and in determining marginal rates of substitution and productivity in frontier facets.

Suppose one wishes to evaluate the relative efficiency of n decision-making units (DMUs), each of which uses varying amounts of m inputs and produces varying amounts of s outputs. Using notation conventions similar to those used by Clark (refer to Note 3), let:

- x_{ij} = the amount of input type i used by DMU j during the period of observation, i = 1,2,...,m and j = 1,2,...,n.
- y_{rj} = the amount of output type r produced by DMU j during the period of observation, r = 1,2,...,s and j = 1,2,...,n.
- x_{ik} = the amount of input type i used by the unit k where k ϵ {1,2,...,k,...,n} and unit k is the DMU being evaluated. Each DMU in turn will be evaluated.
- y_{rk} = the amount of output type r used by DMU_k.
- N = 1,2,3,...,M is the sequence of iterations of the CFA model which ends at iteration M.
- $h_k^{(1)}$ = the upper bound efficiency value sought for DMU_k which is determined from the solution of the first iteration of the CFA.[1]
- $h_k^{(M)}$ = the lower bound efficiency value sought for DMU_k which is determined from the solution of the final iteration (M) of CFA.
- $\nu_{ik}^{(N)}$ = the multipliers for each *input* type i which will be determined by solution of the Nth iterative model.
- $\mu_{rk}^{(N)}$ = the multipliers for each *output* type r which will be determined by solution of the Nth iterative model.
- $s_{rk}^{(N-1)*}$ = the dual surplus values associated with outputs r = 1,2,...,s of DMU_k at optimality of the previous iteration. For the initial iteration, these surplus values are $s_{rk}^{(N-1)*} = s_{rk}^{(0)*} = y_{rk}$.
- $s_{ik}^{(N-1)*}$ = the dual surplus values associated with inputs i = 1,2,...,m at optimality of the previous iteration. Initial values at iteration one are $s_{ik}^{(N-1)*} = s_{ik}^{(0)*} = x_{ik}$.

The following linear programming model is used in CFA for each iteration N = 1,2,...,M:

Primal

$$\text{Max } f_k^{(N)} = \sum_{r=1}^{s} \mu_{rk}^{(N)} s_{rk}^{(N-1)*} + \sum_{i=1}^{m} \nu_{ik}^{(N)} s_{ik}^{(N-1)*} \qquad (1)$$

s.t.

$$\sum_{r=1}^{s} \mu_{rk}^{(N)} y_{rj} - \sum_{i=1}^{m} \nu_{ik}^{(N)} x_{ij} = 0 \text{ for } j \in E_k^{(N)}$$

$$\sum_{r=1}^{s} \mu_{rk}^{(N)} y_{rj} - \sum_{i=1}^{m} \nu_{ik}^{(N)} x_{ij} \leq 0 \text{ for } j \in \bar{E}_k^{(N)}$$

$$\sum_{i=1}^{m} \nu_{ik}^{(N)} x_{ik} = 1$$

$$\mu_{rk}^{(N)}, \nu_{ik}^{(N)} \geq 0$$

where

$E_k^{(N)} \equiv \{j \mid \text{jth constraint holds with equality at optimality at iteration } N-1\}$

$\bar{E}_k^{(N)} \equiv \{j \mid \text{jth constraint is} < 0 \text{ at optimality of iteration } N-1\}$

$E_k^{(1)} \equiv \phi$ (empty), $\bar{E}_k^{(1)} \equiv \{1,2,...,n\}$.

The upper and lower bound efficiency measures are obtained from solution of the first and last iterative models as shown below:

$$h_k^{(1)} = f_k^{(1)} - 1 = \sum_{r=1}^{s} \mu_{rk}^{(1)*} y_{rk}$$

$$h_k^{(M)} = \sum_{r=1}^{s} \mu_{rk}^{(M)*} y_{rk}$$

The dual of model (1) above is:

Dual

$$\text{Min } \omega_k^{(N)} \qquad (2)$$

s.t.

$$\sum_{j \in E_k^{(N)}} \lambda_j^{(N)} y_{rj} + \sum_{j \in \bar{E}_k^{(N)}} \gamma_j^{(N)} y_{rj} - s_{rk}^{(N)} = s_{rk}^{(N-1)*} \quad r = 1,2,...,s$$

$$x_{ik}\omega_k^{(N)} - \sum_{j \in E_k^{(N)}} \lambda_j^{(N)} x_{ij} - \sum_{j \in \bar{E}_k^{(N)}} \gamma_j^{(N)} x_{ij} - s_{ik}^{(N)} = s_{ik}^{(N-1)*} \quad i = 1,2,...,m$$

$\omega_k^{(N)}, \lambda_j^{(N)}$ unrestricted; $\gamma_j^{(N)}, s_{rk}^{(N)}, s_{ik}^{(N)} \geq 0$

[1] The form of the CFA model used in the first iteration is similar to the Data Envelopment Analysis (DEA) model of Charnes, Cooper, and Rhodes (refer to Note 2); however the non-Archimedean infinitesimal quantities are not required.

The mathematical theory and proofs related to the development of this model can be found in Clark's reference (Note 3) and will not be repeated in this paper. But there are a few model characteristics which are worth noting.

First, the efficiency measures $h_k^{(1)}$ and $h_k^{(M)}$ are scalar *ratio* measures. Secondly, the constraints of the primal problem ensure that the maximum achievable value of these efficiency measures is 1. Furthermore, CFA does not require that outputs or inputs have common scales or units of measurement, an important attribute when dealing with difficulties such as nonmonetary objectives and nonpurchased resources. However, all measured input and output values are required to be strictly positive. Finally, each unit is compared to others in the set which have similar input/output mixes; i.e., those units in its "neighborhood."

In short, the CFA model can identify units which are efficient or inefficient relative to a neighborhood frontier region of actual achievement; it can provide a limited number of clues on possible causes from analysis of surplus variables and multipliers; and it is helpful in evaluating the impact of alternative mixes of inputs and outputs.

Furthermore, the information provided by the CFA model is a major improvement over the inadequate, partial (and sometimes inaccurate) measures of performance which are now typically in use in many public service organizations. In addition to its usefulness as a performance monitoring device, this efficiency analysis tool opens the door for further development and growth in other areas of planning, resource allocation, and decision support.

Notes

[1]Farrell, M. J. "The Measurement of Productive Efficiency," *Journal of the Royal Statistical Society*, 120, 3 (1957), pp. 253-290.

[2]Charnes, A., W. W. Cooper, and E. Rhodes. "Measuring the Efficiency of Decision Making Units," *European Journal of Operational Research*, 2, 6 (1978), pp. 429-444.

[3]Clark, C. T. "Data Envelopment Analysis and Extensions for Decision Support and Management Planning," unpublished Ph.D. thesis (Austin, Texas, Graduate School, The University of Texas, 1982).

[4]Bessent, A. and W. Bessent are Co-Directors of the Educational Productivity Council (EPC) which is an organization made up of school districts where participation and membership fees support the development and use of efficiency analysis. The EPC, with headquarters at The University of Texas at Austin, (512) 471-7551, has been in existence since 1980.

[5]Farrell. *Journal of the Royal Statistical Society*, pp. 253-290.

[6]Charnes, Cooper, and Rhodes. *European Journal of Operational Research*, pp. 429-444.

[7]Ali, I., A. Bessent, W. Bessent, and J. Kennington. "Data Envelopment Analysis of the Efficiency of Decision Making Units with the DEA3 Code (Version 3.0)," Research Report EPC 001, Educational Productivity Council, The University of Texas at Austin (February 1982).

[8]Bessent, A., W. Bessent, C. T. Clark, and J. Elam. "Evolution of a Decision Support System for Increasing the Managerial Efficiency of Operating Units," *Program Manager* (forthcoming).

[9]Clark. "Data Envelopment Analysis and Extensions for Decision Support and Management Planning."

[10]Elam, J. has directed the development of decision-support software at The University of Texas at Austin. This effort has been supported by the EPC (see Note 4) and by a grant from the RGK Foundation. Documentation will be available following 1983 field testing and revisions of the code.

[11]Rogers, Albert G., Major General, USAF. *Tactical Air Command Monthly Maintenance Summary, FY8J Wrap-Up*, Langley AFB, Virginia (1981).

[12]Clark, C. T. and R. L. Clarke. "Resource Allocation Model Using Constrained Facet Analysis," Research Report EPC 01, Educational Productivity Council, The University of Texas at Austin, Austin, Texas (May 1983).

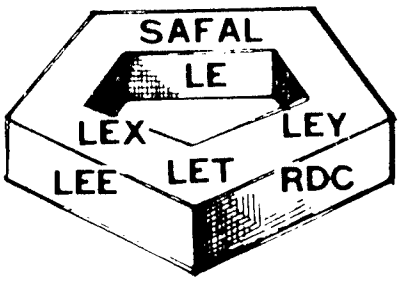
Item of Interest

Professionalization of the Logistics Corps

At the 1984 Logistics Conference, Lieutenant General Leo Marquez asked the senior logisticians to consider ways "to promote the growth of professional logisticians with a solid, general logistics knowledge base." General Marquez also warned that we tend to structure ourselves into narrow, vertical specialties.

The *Air Force Journal of Logistics* has offered to help probe this issue and will devote a section of the Winter issue to papers which discuss the problem and offer a solution. Therefore, would you, our readers, incorporate any ideas, suggestions, and comments into a 3- to 20-page paper and send to us by 1 October 1984. If the response is great enough, we propose to host a mini-conference late in November so the authors of selected papers might personally brief General Marquez.

Please mail your papers (preferably double-spaced, typed) to Professionalization Project, *Air Force Journal of Logistics,* AFLMC/JL, Building 205, Gunter AFS AL 36114.



USAF LOGISTICS POLICY INSIGHT

Long-Range Planning Process

HQ USAF has published a new regulation, AFR 400-13, which describes the procedures for developing and implementing logistics long-range goals, objectives, and strategies. It also establishes the Logistics Long-Range Planning Steering Group and Planning Team who are responsible for logistics planning and programming actions for the future.

HQ USAF/LE holds an annual FUTURE LOOK conference which focuses on logistics long-range planning issues. FUTURE LOOK 84, the fifth in the series, was held at Homestead AFB FL, during 9-12 July 1984, and attended by Air Staff directors, MAJCOM DCSs/Logistics, and their equivalents.

Zero Overpricing Program

The Zero Overpricing Program (directed by AFR 400-17, *Zero Overpricing)* encourages AF personnel at any level, in any job, to formally challenge prices they believe are too high. Challenges that are confirmed as excessive prices are rewarded by cash awards, three-day passes, or other methods of commendation. In 1982-83, 55 monetary awards totaling $39,000 were awarded. A Zero Overpricing monitor at each base supply activity is the contact for initiating the research of price challenges; a Zero Overpricing Committee reviews the challenges and recommends corrective actions or awards.

Commercial Gateways

The Air Force will soon complete the shift of MAC stateside charter passenger operations from military terminals to commercial gateways. Upon completion, the MAC air passenger terminal system will include five stateside civil gateways: two West Coast, a mid-CONUS, and two East Coast. Military charter operations have already been moved to Los Angeles and Oakland International Airports (IAPs), and St Louis IAP was opened to capture the economics of a mid-CONUS gateway. The Charleston International Airport has been selected as the Southeast Civil Gateway, but operations will not be transferred from Charleston AFB until the new civil terminal is completed in early 1985. In the Northeast, charter operations will be shifted from McGuire AFB to Philadelphia IAP on 1 Oct 84.

Alaskan Airlift Augmentation

The Air Force has implemented a Commercial Airlift Augmentation System in Alaska which is designed to provide contract augmentation airlift capability in peacetime to meet contingency requirements in wartime. It serves five sites, including Anchorage, Galena, King Salmon, Shemya, and Adak, and interfaces with the Military Airlift Command (MAC) intratheater channel structure. Military airlift will continue to operate into all sites served by the contract airlift system, but at a reduced rate. The new airlift system will support both passenger and cargo movement requirements. Major objectives are to improve customer support, allow military aircraft to be used for missions with a more tactical requirement, and exercise the Civil Reserve Air Fleet (CRAF) to assure civilian aircraft availability during contingencies.

Reliability and Maintainability in the Air Force

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Introduction

The Air Force has experienced difficulty in programming and budgeting for the support of its weapon systems. For example, Figure 1 shows the Air Force Logistics Command (AFLC) replenishment spares requirements and funding for fiscal years 1976 to 1982.

In response to this dilemma, the Assistant Secretary of the Air Force for Research, Development and Logistics, in a memorandum to the Air Force Vice Chief of Staff, suggested that technology could provide increased supportability and lower overall support costs through more extensive application of reliability and maintainability (R&M) improvements. From that came the research which led to this article.

The ultimate objective of the research project was to obtain a perspective on R&M and assess those areas which offer the greatest potential for support cost improvements. The more specific tasks were to:

(1) Define R&M as applicable to the Air Force.

(2) Show the impact of R&M on operating and support costs.

(3) Determine where and when R&M efforts have the most leverage to reduce operating and support costs (and when they begin to lose effect).

(4) Explore methods of determining how much to spend on R&M.

(5) Describe current Air Force efforts and organizational responsibilities in R&M.

To complete our research, we performed an extended literature review and also interviewed senior Air Force leaders and other persons involved in R&M and acquisition. Based on our findings, we observed specific efforts which could offer significant potential and probability for improved weapon system supportability.

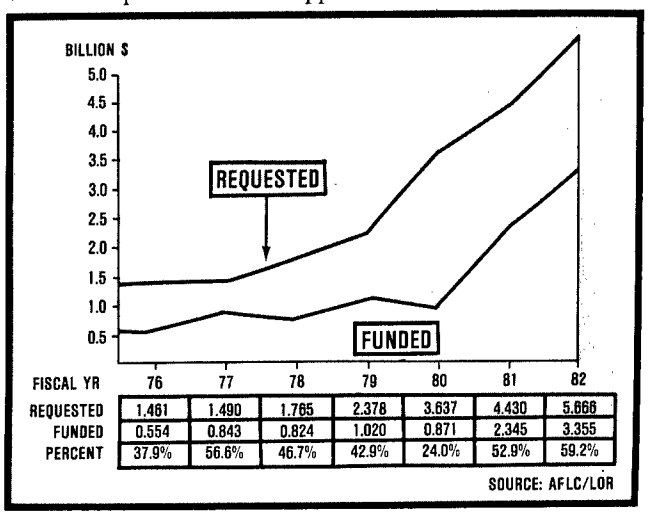
Terms Defined

Since the terms *reliability and maintainability* prompt various responses, the official definitions are:

(1) Reliability - "The *probability* that an item will *perform* its intended function for a *specified interval* under *stated conditions.*" (AFR 800-18)

(2) Maintainability - "The *ability* of an item to be *retained in or restored to specified condition* when maintenance is performed by personnel having *specified skill levels,* using prescribed procedures and resources. . . . ." (DOD Directive 5000.40)

Reliability and maintainability are separate but related concepts which are inherent characteristics of our weapon systems and are intricately involved in system and subsystem interactions. Numerous outside influences contribute to inherent R&M and the actual performance that is ultimately achieved in the field. Despite the many factors that go into a good design, favorable R&M characteristics can only be achieved when a system is designed to operate well in the established operational and support environment.



FISCAL YR	76	77	78	79	80	81	82
REQUESTED	1.461	1.490	1.765	2.378	3.637	4.430	5.866
FUNDED	0.554	0.843	0.824	1.020	0.871	2.345	3.355
PERCENT	37.9%	56.6%	46.7%	42.9%	24.0%	52.9%	59.2%

SOURCE: AFLC/LOR

Figure 1: Replenishment Spares Requirements and Funding.

Influences on R&M

Figure 2 lists some outside factors which not only influence system or component R&M but also the degree to which any benefits are derived from improvements in R&M. Analysts may often ignore the contrary and arbitrary influence the factors might have in mitigating potential R&M savings through their various interrelationships. For example, efforts expended during the design of a system to enhance R&M can be offset or capitalized upon by the operations and maintenance policies or methods used in the field; poor manufacturing controls can destroy the results of a highly successful reliability design effort; or administrative practices could add substantial time to an otherwise quick repair capability.

DESIGN	MANUFACTURING	OPERATIONAL	SUPPORT
Derating	Process Controls	Operator Skill	Maintenance
Redundancy	Material Controls	Mission Profiles	Personnel
Cooling	Testing	User Influences	Policy/Procedure
Materials	Shipping/Handling	Manuals and Data	Administration
Placement		Threat	Facilities
Packaging			Support Equipment
Connectors			Tech Data/Manuals
Safety			Supply System
Mil Specs			

Source: AF/SA

Figure 2: Examples of Interrelated Factors Influencing R&M.

Impact

Reliability and maintainability have significant impact on supportability, survivability, mobility, and system performance and availability.

The cost of support personnel, equipment, and spare parts is directly impacted by R&M. By improving reliability, system failures are reduced, lessening the need for spares and the number of required maintenance actions. Improved maintainability can further reduce the number of spares and maintenance actions, and reduce the need for special test equipment and personnel. Better fault isolation from more accurate, reliable built-in test capability and automatic test equipment can also decrease spares requirements, maintenance actions, and required skill levels. Through improvement in these areas, substantial savings could be realized in manpower, training, equipment, and facility costs.

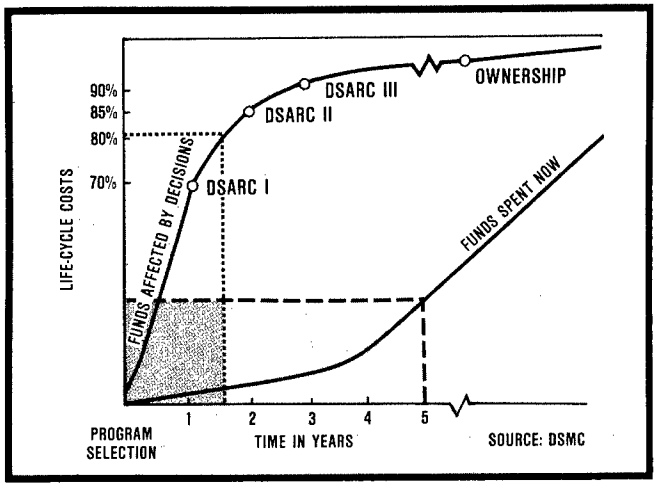
As more hardened aircraft shelters and command and control facilities are constructed, the more lucrative targets our air base runway/taxiway surfaces and the logistics complex that surrounds them will become. Most logistics targets are "soft" which makes them vulnerable to direct and collateral damage. Hardening them is an expensive proposition. Improved R&M may reduce the dependence on some maintenance and supply structures (eliminating the avionics intermediate station), and enhance the survivability of our combat capability. A significant improvement in aircraft subsystem reliability (electronic countermeasures, inertial navigation, bomb/navigation, etc.) would also contribute in combat to the probability of individual aircraft survival and mission accomplishment.

Reliability and maintainability could have a dramatic effect on the mobility of our systems by reducing the numbers and types of personnel, equipment, and spares necessary to deploy in support of combat units. In a study of F-15 intermediate avionics, Rand estimated that a four-fold improvement of 11 line replaceable units (LRUs) (10% of the avionics LRUs in the aircraft) would allow the elimination of the avionics intermediate (test) station for a squadron deployment. The dramatic mobility payoff would immediately delete the requirement for 22 pallets of cargo and 40-50 maintenance personnel per squadron. This improvement would radically limit airlift requirements and provide added flexibility in operating locations.

Reliability directly contributes to system performance. The probability of a system operating as specified for the duration of a mission is a function of component reliability. Fewer failures, more accurate diagnosis and fault isolation, and reduced resource requirements during repairs would substantially improve system availability. Higher availability would not only increase daily peacetime training sorties but would also provide a better starting point for change to a wartime footing. This would concomitantly enhance our ability to sustain higher combat sortie rates. While availability can also be improved by buying more spares or by exceptional maintenance procedures (cannibalization, intensified maintenance activity, etc.), these approaches are those that have led to our current high support costs and budgetary shortfalls.

Timeliness of R&M Decisions and Funding

The important decisions on new weapon systems are generally made early in the concept and development phases. This point is illustrated in Figure 3. The upper curve shows the percent of system life cycle costs committed by major milestone decisions made at the points shown on the horizontal axis. These decisions ultimately determine the support concepts and system R&M characteristics. They also determine the system's life cycle costs, even though the funds affected are not spent until years later, as reflected by the lower curve. By the time the supportability problems of a system are identified, we have usually passed these decision points, and the problems are already locked in. In addition, deferring the near-term costs of R&M testing and design improvements, due to program cost and schedule constraints, can result in significantly higher support costs over the extended system life cycle. Addressing these problems through later modifications creates the extra expense of buying subsystem R&D, installation quantities, spares, technical data, and personnel training for a second time (the initial system plus the modification).



Note: DSMC = Defense Systems Management College
DSARC = Defense Systems Acquisition Review Council

Figure 3: Timeliness of R&M Decisions and Funding.

Acquisition/Support Costs Vs R&M

In a 1974 study of reliability and availability, the Logistics Management Institute (LMI) developed a set of models to optimize reliability aspects of a weapon system, relative to life cycle costs. In Figure 4, the left chart shows the trade-off between system acquisition cost and life cycle operating costs. The more spent on supportability during development, the lower the system life cycle support costs. However, at some point, additional development cost exceeds potential savings—thus the traditional shape of the total cost curve. But as the graph on the right shows, the resultant mission reliability may not be acceptable when total cost is at its

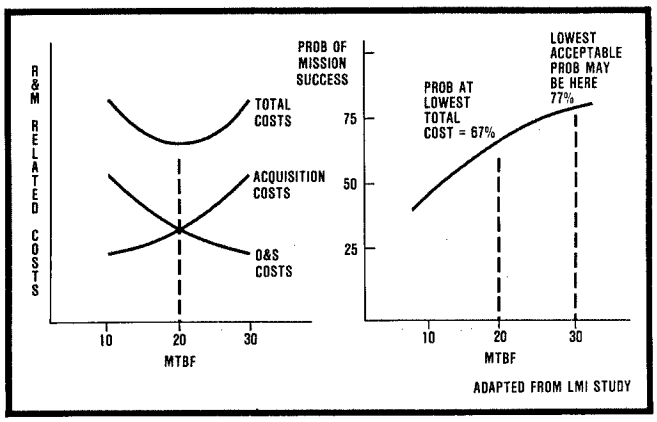


Figure 4: Acquisition/Support Costs vs R&M.

lowest. Therefore, it is necessary to consider required mission reliability as well as the purely cost-effective level of effort to determine actual R&M requirements. Optimizing these relationships can lead to substantial benefits, as shown in Figure 5.

SYSTEM	ADDITIONAL INVESTMENT IN R&M ($ MILLION)	NET LIFE CYCLE COST SAVINGS ($ MILLION)	PERCENT RETURN ON INVESTMENT OVER 10 YEARS
F-4C	$ 134	$ 453	338
F-105D	194	580	299
B-52H	76	185	240
C-141A	271	1,608	593

AVG PERCENT IMPROVEMENT IN PROB OF MISSION SUCCESS: 54%

AVG LCC SAVINGS: 27%

AVG R&M INVESTMENT AS PERCENT OF PRESENT LCC: 8%

Adapted from LMI Study

Figure 5: Potential Return on R&M Investment.

LMI developed an optimization technique to determine the system reliability that would result in lowest life cycle costs. Based on actual historical costs and reliability data of the four weapon systems shown, the Institute determined the potential savings (Figure 5) that could have been realized if system reliability had been optimized relative to support costs early in system development. While additional funds would have been required to accomplish this development, substantial returns were indicated and a significant improvement in the probability of predicted mission success occurred. These results are admittedly based on hindsight—and early prediction of these values may be difficult—but the example does illustrate the great potential for return on investment in R&M.

Achieving R&M

Many subsystems that go into new aircraft are on test benches years before they are integrated into a system. The emphasis on R&M needs to begin at this early point to avoid subsequent shortfalls. During the concept phase, specific and meaningful R&M definitions and requirements in the statement of need (SON) and statement of work (SOW), and strong emphasis during the system's formative stages, are critical to proper consideration of R&M requirements. By the end of design, the inherent upper limit of R&M of the system is nearly locked in. Development and testing, particularly of total system prototypes, offer the last relatively low-cost opportunity to identify and correct R&M deficiencies. Reliability growth is a necessity in the total R&M program; it is inherent in the identification and correction of failure modes and problems not identified earlier during the design or testing stages. The operation of the system in its true environment as soon as possible will probably cause new failure modes to surface, and these must also be corrected quickly to protect the payback of earlier efforts. Finally, as mature system R&M values are attained, we must track unfavorable trends or changes that degrade R&M and, as new technologies offer the opportunity for significant improvements, we must then incorporate them into the system.

R&M Modifications

The existing force would appear to offer fertile ground for application of new technology to improve supportability and reduce costs. However, we should conduct careful analysis to ensure that a given investment is productive. Figure 6 illustrates the need to analyze the weapon system as a whole. In this example, the bombing navigation subsystem provides the greatest constraint on mission accomplishment. Assuming a substantial improvement in that subsystem, flight controls become the next major constraint. The worth of an R&M improvement in bombing navigation in this hypothetical case is constrained by the total system interaction. Commonality of subsystems among other aircraft further complicates the analysis. The Air Staff's Logistics Concepts Division (AF/LEXY) is presently working on a badly needed methodology to make better informed decisions on aircraft R&M modifications.

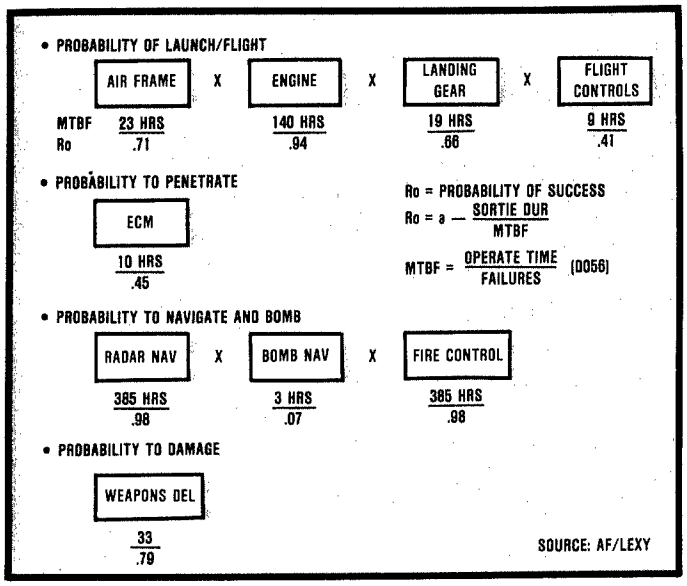


Figure 6: Interactions of Subsystem Reliabilities.

Current Air Force Structure

Many Air Force organizations participate in various aspects of R&M. At the Air Staff level, the Acquisition Logistics Communications Group (AF/LEYE) is the OPR for AFR 800-18, *Reliability and Maintainability*. Throughout the Air Staff, program element monitors oversee the development of new systems, and the Deputy Chief of Staff, Research, Development and Acquisition (AF/RD), has several active R&M development program elements. The AFLC Logistics Operations Center is that command's OPR for R&M, though most of the command's efforts are undertaken at five air logistics centers. The Air Force Acquisition Logistics Center has the responsibility for ensuring that supportability issues are properly considered during the acquisition of new systems, and it does do substantial interfacing with the various acquisition organizations.

In the Air Force Systems Command (AFSC), a Special Assistant for Product Assurance reports directly to the Commander, and a Deputy for Acquisition Logistics has been established with a Product Assurance Directorate (ALK). AFSC's product divisions and various laboratories do, or oversee, developmental work in R&M, and the system project offices for each new system are responsible for the development of reliable, supportable systems. The Product Performance Agreement Center, which is a joint effort by AFLC and AFSC, collects and disseminates data on the

effectiveness of various contracting techniques, including R&M initiatives.

The major commands individually track their weapon systems for R&M trends or "bad actors" and interact with AFLC to identify them for resolution. There are other organizations also involved in developmental, test, or research work that includes R&M. Each reports through its respective chain of command, but there is little centralized coordination or integration of efforts and proposed results.

R&M Requirements Development

In the past, statements of required operational capability (ROC) or SONs have not adequately addressed the R&M requirements of new systems. In part this may have been due to lack of meaningful, quantitative methods to derive, state, and measure the desired characteristics. Requirements have not been based on analysis of needs but on comparison with existing systems, or vague generalities. SOWs, written by people lacking real experience in the support areas, tend to follow the SONs. The SON for the advanced tactical fighter attempts to remedy this situation. However, Rand, in an analysis of requirements determination and documentation, has found even this latest approach to be somewhat lacking, but it still contains the traditional R&M measures.

R&M in the Future

Several new technologies offer the potential for significant R&M improvements. Very high speed integrated circuits (VHSIC) offer substantially faster processing times and further miniaturization. More processes occurring on a single chip at faster speeds allow for more redundancy and less connectivity problems, as well as standard function chips to build commonality into otherwise different subsystems. Fiber optics may also contribute to the elimination of connectivity problems. Artificial intelligence may soon allow a weapon system to constantly assess its subsystems and reprogram in flight to optimize the system for specific mission requirements. New composite materials offer substantial improvements in strength versus weight. Computer-aided design and manufacturing will enhance efforts to design reliable systems and help maintain inherent reliability during the manufacturing processes. Improved component self-diagnostic capabilities could substantially reduce maintenance fault isolation times and help eliminate the false alarm removals that constitute from 20% to 50% of electronic component removals.

The new technologies mentioned are only a few areas in current development, but new capabilities will also bring new problems. How do we deal with graceful degradation, where a subsystem loses a percentage of its components and still operates, either without degraded performance or within an acceptable level? Defining a failure in such an environment and measuring system R&M will be a challenging task. Increased redundancy and self-programming will further complicate the problem. As equipment mean time between failure (MTBF) improves, testing for adequate periods of time to obtain statistically significant numbers of failures will become a serious issue. New materials bring new and unexplored failure modes and will require new procedures and skills for inspection and repair. The escalating complexity of systems and increasing sophistication of components and repair methods will also bring increased training and education requirements for the people who repair them at field and depot levels. Systems should be designed in such a way that this specialized experience is needed only at centralized technology repair centers.

Potential Areas of R&M Improvement

Given the choice between new developmental efforts and modification of existing systems, new systems offer much more leverage for R&M efforts. While there are few major new starts programmed for the next decade that have not progressed beyond the point where much of the R&M initiative has passed, early developmental work of advanced subsystems could provide a set of proven, reliable building blocks for future development and selective retrofit. A methodology to select the optimal mix of R&M modifications, such as the one under development in AF/LE, will help determine the best way to apply these improvements.

The electronics area offers opportunities for revolutionary advance, particularly components which are intensive in microprocessors and memory storage. Built-in test capability and automatic test equipment are areas that need improved reliability; substantial benefits could accrue through reduced removal rates, more accurate fault isolation, and more reliable and timely processing.

In addition to component and system development, several conceptual efforts could contribute to the R&M characteristics we need in future systems. New methods of measuring and testing parts on total systems for R&M are needed—to improve on present methods and address the new problems developing along with technology. New weapon system architectures should be considered to avoid building better versions of the same old black boxes, when a new approach could lead to order-of-magnitude improvements in total system reliability, maintenance policy and procedure, and other support concepts. Work could be done to take better advantage of the concepts of graceful degradation and on-line, in-flight reprogrammable components.

Summary

Our research indicates that R&M does offer the opportunity for significant improvements in controlling system operating and support costs and improving availability. In general, the best return on investment is achieved when the R&M effort occurs early in system concept definition and design. The areas presently offering the greatest opportunity for payback are in development and incorporation of new electronic technologies and architectures, conceptual work in measuring and testing R&M, better determination and specification of R&M requirements, and continued efforts to better manage and acquire reliable and maintainable weapon systems.

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4. "Reliability and Maintainability in the Air Force," white paper, HQ USAF, ACS Studies and Analyses, Washington, DC 20330, May 83.

1984

AIRPOWER APS SYMPOSIUM

A Brief of Security Assistance Legislation

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Introduction

The purpose of this article is to provide a very brief background or history of security assistance legislation. No attempt at this time will be made to offer a commentary on the laws themselves. Most of this legislation is of relatively recent origin, but military assistance does occur early in American history. As every student knows, the American Revolution was brought to a timely conclusion as a result of massive military assistance provided by France and Spain.

Background

Until the end of the nineteenth century, the course of world events raised few threats to the security of the United States (US). "Splendid Isolation" was more than a shibboleth; it was a geographical and political fact of American life. Since a foreign threat seemed so far away—indeed if it existed at all—international logistics, or security assistance, in its broader sense, was not a public issue. Yet, from the Civil War onward, the US was a leading arms exporter. The trade was accepted as routine and did not warrant stringent executive or legislative control.

As the US entered the twentieth century, it was rapidly becoming one of the greatest industrial nations on earth. At the outbreak of World War I in 1914, segments of the industrial base capable of mass production turned to the manufacture of small arms, ammunition, military vehicles, and a miscellany of other war materials, along with all manner of support equipment. The trade in munitions grew as the war progressed.

While the US was still ostensibly neutral, the prominent international lawyer, Charles Hyde, petitioned Robert Lansing, then Secretary of State, to reduce the US's commercial arms trade. Hyde charged that the US was becoming a "base of supplies of such magnitude that unless retarded, the success of armies, possibly the fate of empires, may ultimately rest upon the output of American factories." Lansing's reply, consistent with international law of that time, was that private citizens in a neutral country could lawfully sell military supplies to a belligerent country.

America's entrance into World War I turned the tide. In addition to an avalanche of basic war materials, the US abundantly supplied to the European allies three other indispensibles: men, food, and money. In the months following the war, American idealism was shattered by the hard realities of international politics. The idea of peace through disarmament gained momentum, and by terms of the widely accepted Pact of Paris, signatory nations condemned recourse to armed conflict as a solution of international controversies and renounced war as an instrument of national policy.

It is an ironic and paradoxical fact that the US, while in the vanguard of the disarmament movements, was still at the same time one of the world's leading arms exporters. The magnitude of the American presence in the international arms market was suggested by the fact that, by 1920, US sales accounted for more than 52% of the global arms exports. This was the source of considerable controversy which was reflected in widespread public debate and discussion throughout the 1920s and 1930s. The book, *Merchants of Death,* was an example of the contemporary literature that nagged the American conscience.

In the early 1930s, new threats to peace were rapidly taking shape. With the League of Nations helpless and in a state of disintegration, and with war clouds gathering in both Europe and Asia, the near obsession of the American people was to avoid becoming embroiled in foreign conflicts. In response to the prevailing attitude, Congress passed a series of neutrality acts.

The first of these, the Neutrality Act of 1935, in the form of a joint resolution of Congress, made these provisions: when two or more states went to war, the President would recognize and proclaim the fact. Thereafter, it would be unlawful to export arms, munitions, or implements of war from any port of the US to any belligerent port, or to a neutral port for transshipment to any port of a belligerent country.

Later, the Neutrality Act of 1937, while continuing to prohibit the sale of arms, ammunition, and implements of war, did make some fateful exceptions. Raw materials, such as copper, cloth, and oil, could be sold if the belligerents sent their ships to American ports and paid for their purchases before departure. This escape clause was known as "cash and carry." The neutrality acts gave the US little comfort and security and had no effects whatsoever in the fast-moving events in Europe.

Hitler invaded Poland on 1 September 1939. France and Great Britain thereupon declared war on Germany. Nine months later, France surrendered. Britain carried on alone and was assailed by land and sea. Reduced to desperation, Churchill appealed to Roosevelt for a loan of ships. Roosevelt's response was an executive agreement completed on 2 September 1940, by which he transferred 50 old US destroyers to the Royal Navy. In this unusual arrangement, the President had bypassed Congress entirely. Further, this bold transfer of arms made the US virtually an ally of Britain and violated existing international law and, most probably, domestic law as well.

However, it should be further noted that the American people were in substantial support of the executive use of "implied powers" in the 50-destroyer case as witnessed by the President's tradition-shattering election for a third term.

Act to Promote the Defense of the US

Encouraged by his re-election, the President boldly advocated greater aid to all who opposed the tyranny of Adolph Hitler. He sponsored a bill which would authorize

providing arms in large quantities on very liberal terms to those nations opposing the dictators. The formal title of the bill was "An Act to Promote the Defense of the United States," but the convenient title, "Lend-Lease," has endured. It should be noted that at this time the US was technically at peace. The bill was passed in both the House and Senate by impressive majorities.

"Lend-Lease," which became law on 11 March 1941, nine months before Pearl Harbor, unequivocally permitted the President, "notwithstanding the provision of any other law," to authorize the manufacture and procurement of "any defense articles he deemed vital to the defense of the United States." The President was further permitted "to sell, transfer title to, exchange, lease, lend, or otherwise dispose of to any such government any defense article. . . ." The terms and conditions upon which a foreign government received aid under the Lend-Lease Act would "be those which the President deemed satisfactory."

In summary, this unprecedented law vested the President with sweeping powers to be used at his discretion and under his direction, and on terms to be arranged by him. This enabled the President to put the financial and industrial resources of the US government (but not yet the manpower) at the disposal of countries whose defense, in his judgment, was vital to the defense of the US.

Following Pearl Harbor, the US became "the arsenal of democracy." By the end of World War II, it had delivered goods and services worth more than $50 billion, an astronomical amount for that time. Thirty-eight countries had benefited.

The National Security Act of 1947

In the postwar period, the Soviets made demands on Turkey for joint control of the Dardanelles and for territorial concessions in Anatolia. Greece was the victim of exterior communist aggression and communist inspired civil strife. As a result, both Greece and Turkey appealed to the US for assistance.

President Truman's reaction to the appeals was immediate and positive. He addressed Congress on 12 March 1947 and presented a message which was destined to be a landmark in US foreign policy. The heart of President Truman's plea and the enduring philosophy which he so eloquently and persuasively announced is well-illustrated in this passage:

> One of the primary objectives of the foreign policy of the United States is the creation of conditions in which we and other nations will be able to work out a way of life free from coercion. . . . We shall not realize our objectives, however, unless we are willing to help free people to maintain their free institutions and their national integrity against aggressive movements that seek to impose upon them totalitarian regimes. . . .
>
> I believe that it must be the policy of the United States to support free peoples who are resisting attempted subjugation by armed minorities or by outside pressures. . . . The free people of the world look to us for support in maintaining their freedom. If we falter in our leadership, we may endanger the peace of the world—and we shall surely endanger the welfare of our own nation. . . .
>
> In addition to funds, I ask the Congress to authorize the detail of American civilian and military personnel to Greece and Turkey, at the request by those countries, to assist in the task of reconstruction, and for the purpose of supervising the use of such financial and material assistance as may be furnished.

Congress responded to the President's request by including it (commonly referred to as Truman Doctrine) in the National Security Act of 1947, which authorized economic aid and military assistance. Appropriations amounting to $625 million were provided to support these programs.

The Truman Doctrine is generally accepted as the initial commitment of the US to the concept of collective security. In principle, it still constitutes the heart of the US military and economic aid programs that followed, as well as those that are active at this time. The US has maintained a military assistance presence in both Greece and Turkey since 1947. Both countries are members of NATO and both provide bases of operations for US forces, and for other purposes.

The Economic Cooperation Act of 1948

On 5 June 1947, only three months after the Truman Doctrine, General George C. Marshall, then President Truman's Secretary of State, speaking at the Commencement Exercises at Harvard University, suggested that the nations of Europe should get together and devise cooperative plans for their economic recovery. Sixteen nations were quick to realize the great potential of the Marshall offer. Meeting in Paris, they diligently worked out their plans for recovery and forwarded their shopping lists to Washington. The European estimates were presented to Congress in December 1947. The bill, the Economic Cooperation Act, authorized the first of the Marshall Plan appropriations. It was passed by large majorities in both Houses.

"The Marshall Plan was a spectacular political and economical success; it was a major step forward in free world cooperation."

The European Recovery Plan—far better known as the "Marshall Plan"—was basically economic in nature, but it had military implications. Today, we would call the Marshall appropriations "Economic Support Funds." Altogether, Congress approved a sum of about $13.2 billion over a four-year period and, within two years, the participating European countries had exceeded their prewar levels of productivity. The Marshall Plan was a spectacular political and economical success; it was a major step forward in free world cooperation.

The Mutual Defense Assistance Act of 1949

As 1940 came to an end, the Cold War became more and more a threat to the peace of the world and to the security of the noncommunist nations. The United Nations Security Council was rendered impotent to deal with communist aggression, the control of atomic energy, the reduction of armaments, or the peaceful settlement of international disputes, due, for the most part, to repeated Soviet vetoes. Under the constant threat of Soviet obstruction and aggression, there was no other course for the West but to cooperate.

Responding to the common danger, the representatives of 12 nations met in Washington and, after a very successful conference, agreed to and signed the North Atlantic Treaty on 4 April 1949, which authorized the North Atlantic Treaty Organization, or NATO. The heart of the North Atlantic Treaty was Article V, which declared, *inter alia*, that the parties agreed an armed attack against one or more of them in Europe or North America would be considered as an attack against them all.

In the years immediately following World War II, the European members of NATO were struggling for economic survival. Diversion of their limited resources for rearmament would have seriously retarded or impaired their progress toward recovery. If NATO were to be converted into a viable defensive organization, then massive military assistance must be forthcoming from the US.

On the same day that President Truman signed the instrument of ratification of the North Atlantic Treaty, 25 July 1949, he submitted a message to Congress requesting legislation which would authorize "military aid to free nations to enable them to protect themselves against the threat of aggression." In view of the economic conditions in Europe, the President proposed that military assistance be provided on a non-reimbursable basis. It may be appropriate to note that from the inception of the postwar military assistance programs, and for well over a decade thereafter, the great preponderance of military assistance provided to our numerous allies was furnished as Grant Aid; i.e., the recipient nations had no financial obligations to pay for what they had received.

Congress approved the President's message by the passage of The Mutual Defense Assistance Act of 1949. Section 401 stated that "Military Assistance may be furnished under this act, without payment to the United States. . . ." The Mutual Defense Assistance Act set a pattern for future Grant Aid legislation.

The Mutual Security Acts

The outbreak of hostilities in Korea, on 25 June 1950, abruptly changed the whole philosophy and sense of immediacy about the defense tasks faced by the free world and the manner and scope of the contribution which the US should make to the common defense. By the beginning of 1951, the major emphasis of the foreign aid program was rapidly shifting from economic to military objectives. This shift would be complex and very expensive and would require better coordination of all foreign assistance activities. What was hoped to be a more efficient planning and coordinating structure was included in the Mutual Security Act of 1951.

Aside from Grant Aid appropriations, the major accomplishment of the Mutual Security Act of 1951 was the reorganization of the several aid programs. A new administrative organization, the Mutual Security Agency, was created. The head of the new organization, the Director of Mutual Security, was made technically responsible for all aid programs. The Director of Mutual Assistance shifted the responsibility for managing military assistance to the Secretary of Defense.

One of the most enduring and significant parts of the Mutual Security Act of 1954 is Section 414, directing the President to designate those articles which shall be considered as arms, ammunition, and implements of war, including technical data relating thereto. This compilation constitutes the still valid Munitions List and serves as a guide in the control and licensing of military exports.

The Korean War, with support given to the Republic of Korea's armed forces, was responsible for new and taxing demands on the American arsenal. A large part of the early 1950 appropriations was used for supplying heavy and specialized military equipment for the expanding forces of the NATO countries, then under the command of General Dwight D. Eisenhower (1950-52).

The magnitude of the military assistance Grant Aid programs during the early 1950s can best be illustrated by a citation of appropriations. For FY 1951 the appropriation was $5,222,500,000; for FY 1952, $5,744,000,000; and for FY 1953, $4,219,800,000.

The Foreign Assistance Act of 1961

The Foreign Assistance Act of 1961 became effective on 4 September 1961 and superseded the Mutual Security Act of 1954. The Foreign Assistance Act of 1961 was designed to give new vigor, purpose, and direction to all types of foreign aid. It provided for comprehensive programs of assistance to friendly foreign countries and created a new administrative body, the Agency for International Development (AID). It should be noted that The Foreign Assistance Act was double-barreled: it provided for economic and technical aid, particularly for the developing countries, and it also provided for military assistance to countries unable to arm themselves. The congressional objective in passing the Act was not to reduce the magnitude of program activities but to improve their direction and administration.

"During the presidencies of Kennedy and Johnson (1961-69), there was a dramatic increase in the volume and value of foreign military sales (FMS)."

Section 507 of The Foreign Assistance Act of 1961 authorized the President to sell defense articles from the stocks of the Department of Defense (DOD) and defense services from the same source to any friendly country or international organization. Although the Act was oriented to Grant Aid, by the time of its passage, Grant aid programs were in decline. During the presidencies of Kennedy and Johnson (1961-69), there was a dramatic increase in the volume and value of foreign military sales (FMS). In 1964, the value of sales for the first time exceeded the value of Grant Aid.

Arms Export Control (FMS) Act of 1968

Although the sale of arms by the DOD had long been a legal procedure, the great increase in the volume of sales, along with the need for better management, prompted new legislation which revised and brought together previous authorizations into a single measure. The Foreign Military Sales Act of 1968 became law on 22 October 1968. Congress recognized in this basic legislation that free and independent countries had a valid need for the means of self-defense in order to maintain and foster the environment of international peace and security essential to social, economic, and political progress. Congress further recognized that, because of the growing cost and complexity of defense equipment, it had become increasingly difficult and uneconomical for any country, particularly a developing country, to fill all its defense requirements from its own design and production base. Therefore, the need of allies and friendly countries for arms to resist aggression and to facilitate the common defense should be met.

Accordingly, The Foreign Military Sales Act of 1968 authorized the President to sell defense articles from the stocks of the DOD and defense services from the same source, to any

friendly country or international organization if such country of international organization agreed to pay not less than the value of the articles or services received in US dollars. The President was granted the power to enter into contracts for the procurement of defense articles and defense services on behalf of friendly countries and international organizations. He was given discretionary powers to extend credits and to guarantee loans when such credit and loans would enable friendly countries and international organizations to purchase arms and services from the US.

Congress further stipulated that all FMS sales would be approved only when they were consistent with the foreign policy interests of the US and with the economic and financial capabilities of the purchasing country. Defense articles and defense services would be sold to friendly countries exclusively for internal security, for legitimate self-defense, and for participation in regional and collective arrangements or measures consistent with the Charter of the United Nations.

The International Security Assistance and Arms Export Control Act of 1976

The progressive increase in the sale of arms during the 1970s became a subject of widespread domestic concern and criticism. Congress, in previous years, had been content to make the sale and gift of arms an executive responsibility. Under the Arms Export Control Act of 1968, as well as the Foreign Assistance Act of 1961, the Secretary of State, under the direction of the President, was made responsible for the continuous supervision and general direction of sales, which included, but was not limited to, determining whether there would be a sale to a country and the amount thereof. In the waning days of the Ford administration, Congress reasserted its authority to exercise control over arms transfers. This was accomplished by the passing of the International Security Assistance and Arms Export Control Act of 1976. Inasmuch as this Act is current and applicable, some of its provisions which have made significant changes in security assistance and FMS procedures will be noted here:

- After 30 September 1977, Grant aid would exist only as authorized by Congress for specific countries in specified amounts. It is interesting to note that this Act provided Israel with $1.25 billion of "forgiven" funds, but these funds were not called, nor appropriated, as Grant Aid.
- The total number of Military Assistance Advisory Groups were drastically reduced, and thereafter MAAGs and similar groups would operate only when specifically authorized by Congress.
- Personnel performing defense services which are sold may not perform any duties of a combat nature including any duties related to training, advising, or otherwise providing assistance regarding combat activities, outside the US in connection with the performance of those defense services.
- Sales of defense articles which could have significant adverse effect on the combat readiness of the Armed Forces of the US shall be kept to an absolute minimum.
- Security assistance, including FMS, will not be extended by the US to any country which as a matter of policy:

a. Violates basic human rights.

b. Discriminates against US citizens engaged in furnishing security assistance.

c. Offers sanctuary to terrorists.

d. Transfers items or services sold or given by the US to other parties without presidential consent.

e. Engages in irregular or unlawful nuclear transfers.

- Civilian arms dealers must be registered with and be licensed by the State Department.
- Contributions, gifts, and fees must be legally permissible and promptly reported.
- Sales of major defense equipment exceeding $14 million in value or any FMS sale over $50 million would henceforth be subject to congressional review for approval or rejection. Commercial export of military articles and services would also be subject to State Department and congressional control. It should be noted that the Supreme Court by a recent decision had invalidated the congressional veto of FMS.

For many years, the military services were prohibited by law from buying in anticipation of FMS. In 1982, Congress has approved a new budgetary account to expedite the procurement of defense articles and services. Such advanced procurement will reduce delivery lead times and allow more rapid response to the security needs of friends and allies, while at the same time protecting US force readiness. This new account is called the Special Defense Acquisition Fund.

"Now major negotiations become familiar to all Americans as the interplay between Congress and the President unfolds."

The President, by the Arms Export Control Act of 1976, as amended, is authorized to require that any particular arms sale be made a government-to-government FMS rather than a commercial sale. Persons engaged in the negotiation of a potential commercial arms sale, if so directed, will keep the President informed on the progress of such negotiations.

Summary

This exposition has been sketchy at best but serves to remind us of the changes that have taken place in US military assistance programs. Now major negotiations become familiar to all Americans as the interplay between Congress and the President unfolds. We need, as citizens, to be wary of the directions being taken by our leaders.

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1984 AIRPOWER APS SYMPOSIUM

Security Assistance: A Visual Overview

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Security assistance is a major part of United States (US) efforts to implement collective mutual security. In a world of fit and alert friends, the neighborhood bully finds disruption and dislocation hard going.

More specifically, US objectives are threefold:

- **Strengthen allies and friends**
- **Enhance force projection and coalition defense**
- **Promote mutual understanding and cooperation**

The program itself is both a Department of State and Department of Defense (DOD) effort with the following delineation:

DOD is responsible for:

- **Military assistance program**
- **International military education and training**
- **Foreign military sales**
- **Foreign military sales (credit)**

State is responsible for:

- **Peacekeeping operations**
- **Economic support fund**

Congress watches the program through:

- **Arms Export Control Act as amended which oversees all cash sales and foreign military sales credit financing**
- **Foreign Assistance Act which specifically authorizes the military assistance program, the international military education and training program, the economic support fund, and any peacekeeping operation**

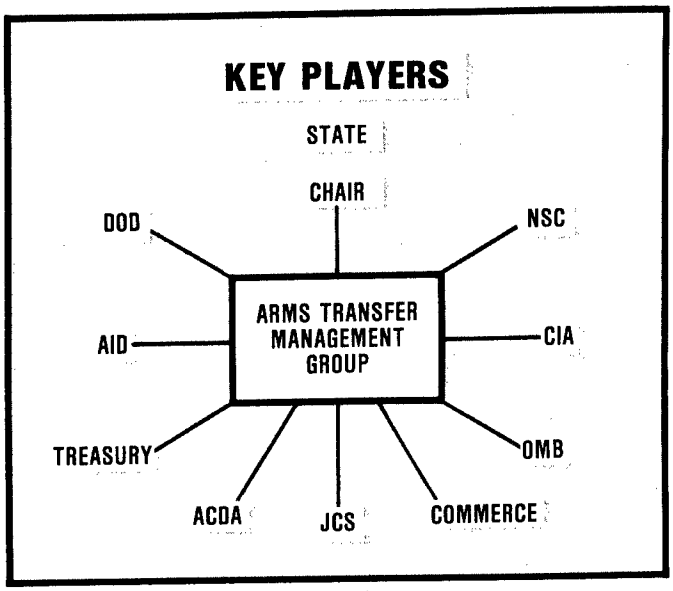

Figure 1.

DIRECTORATE OF INTERNATIONAL PROGRAMS MISSION STATEMENT

- AF/PRI IS OPR FOR THE CENTRAL MANAGEMENT, DIRECTION, GUIDANCE, AND SUPERVISION OF THE AIR FORCE POSITION OF THE MILITARY SECURITY ASSISTANCE (SA) PROGRAM FOR FOREIGN NATIONS AND INTERNATIONAL ACTIVITIES.
  - ENSURES OVERALL INTERFACE OF SA PROGRAMS WITH OTHER USAF PROGRAMS
  - COORDINATES ON AIR FORCE POLITICO-MILITARY POLICIES AS THEY AFFECT SA MATTERS AND ACTIONS WITH ALL PERTINENT DOD, STATE DEPARTMENT, AND OTHER AGENCIES AND GROUPS RELATING TO SA MATTERS
  - COORDINATES AS AIR STAFF FOCAL POINT (WITH DSAA) ON USAF SA PROGRAMS
  - COORDINATES AS AIR STAFF COUNTERPART OFFICE FOR JOINT ARENA ACTIONS DEALING PREDOMINANTLY WITH FOREIGN MILITARY SALES (FMS) AND OTHER SA PROGRAMS

Figure 2.

The key committee in the Senate is Foreign Relations, while in the House, it is Foreign Affairs.

In the executive branch, the program is managed by the Arms Transfer Management Group which is portrayed in Figure 1. Within the USAF, the management of all security assistance is in the Directorate of International Programs. Figure 2 is the mission statement of HQ USAF/PRI. Air Force has established several rules of the game which are listed in Figure 3. Figure 4 shows the process itself from the original discussions between the customer and HQ USAF to the final act of the offer. The end result is collective mutual security after several hard-working stages of implementation and support are passed.

Editor's Note: General Baker's comments were delivered extemporaneously before the Air Power Symposium of 1984. His remarks so well covered the mechanics of the program that we decided to publish them.

RULES OF THE GAME

- **NO EXPENDITURE IN ANTICIPATION OF SALES**
- **RECOVERY OF ALL COSTS**
- **ADMINISTRATIVE COSTS LIMITED TO 3% OF SALES**

Figure 3.

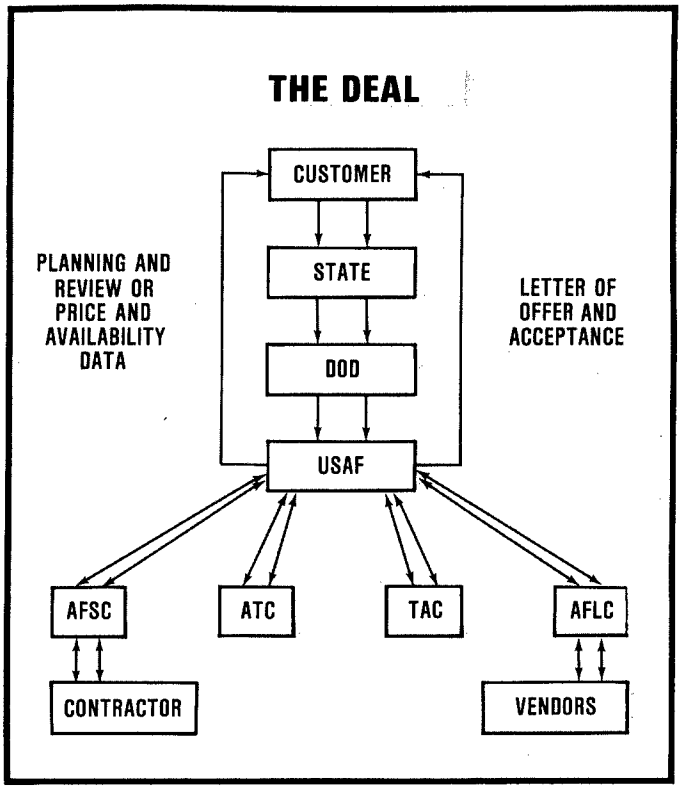

Figure 4.

FROM 36 (AFIT THESES)

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Captain Edward R. Perkins, II — ADA135585
Time Series Analysis of Production Oriented Maintenance Organizations — LD56711MA

An Introduction to the NATO Mutual Support Act

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Abstract

In 1980, the NATO Mutual Support Act (NMSA) was enacted into law with the overall purpose of enhancing the readiness of NATO forces through simplified procedures for the exchange of logistics support. The law had two primary results:

(1) To render certain provisions of United States (US) contract law inapplicable to acquisitions of logistics support from other NATO governments or subsidiary bodies. While the contract law provisions in question are appropriate for domestic government-to-government contractor relationships, they are unnecessary in dealing with foreign governments.

(2) To provide a legal authority for replacement-in-kind (RIK) or exchange of logistics support within NATO.

This article reviews the need for the legislation, the current status of implementation, eight common myths about the law, and the readiness benefits expected for the United States Air Force (USAF). The article also contains several recommendations to improve the program and make it a better tool for vitally needed international logistics cooperation in the NATO environment.

Introduction

To amend Title 10, United States Code, to authorize the Secretary of Defense to enter into certain agreements to further the readiness of the military forces of the North Atlantic Treaty Organization.[1]

For years, the US has stressed closer cooperation with our NATO allies to achieve, among other objectives, a higher state of readiness as envisioned by the NMSA. Enacted in August 1980, the Department of Defense (DOD) vigorously supported the legislation for several years before its ultimate passage. While the law was intended to achieve a number of different objectives, there were two principal problems which caused DOD to seek the legislation.

First, representatives of other NATO governments were often concerned when certain provisions of the Armed Services Procurement Act (as implemented by the Defense Acquisition Regulation (DAR)) and other sections of US law relating to procurement were invoked as DOD made acquisitions. The provisions of US procurement law found to be particularly disagreeable to our NATO allies were those primarily designed for government-to-contractor relationships, such as our requirement to state in writing that gratuities had not been involved in a contract.[2] While these provisions may be necessary when DOD conducts business with domestic private contractors, DOD argued, and Congress accepted, the position that they were not needed in dealing with other NATO governments. In fact, these provisions often hampered meaningful logistics cooperation among the NATO allies. For example, when it was determined that DAR procedures were necessary to acquire certain logistics support, foreign governments often delayed or even refused negotiations. For the USAF, these DAR provisions were particularly troublesome in the acquisition of equipment or supplies, which according to legal interpretation, must comply with US procurement law. However, international agreements for research and development and host nation support services often fall outside the scope of the DAR.[3] A key DOD objective in seeking legislative relief was to ease contracting difficulties in order to take maximum advantage of the considerable logistics support available in host European countries.[4]

"A key DOD objective in seeking legislative relief was to ease contracting difficulties in order to take maximum advantage of the considerable logistics support available in host European countries."

The second problem giving rise to the legislation was the need for additional authority for responsive cross-servicing; i.e., involving RIK or exchange of logistics support. In this context, the term "cross-servicing" involves the government of one country providing logistics support, supplies, or services to the government of another country. This was deemed necessary to facilitate use of the numerous opportunities for such support during joint deployments and exercises as well as repair of transient US or allied aircraft at nonnational airfields.[5] While some authority for RIK existed (exchange of fuel by USAF with other countries), it was limited. Generally, DOD acquired logistics support using standard DAR procedures. And, normally, we could only sell under the purview of the Arms Export Control Act (foreign military sales), which does not lend itself to rapid international cross-servicing support. Obviously, this situation did little to promote cross-servicing between the US and other NATO members for activities such as international "lateral support" to satisfy not mission capable supply (NMCS) conditions.

With the passage of the NMSA, DOD obtained the authority to acquire logistics support, supplies, and services, rendering inapplicable nine provisions of US contract law. Further, DOD could also enter into cross-servicing agreements which would involve RIK as well as "cash" transactions. An RIK transaction means, for example, if the USAF receives an aircraft spare from another NATO country, we are obligated to provide that same item (in the same condition except for normal wear and tear) or an identical or substantially identical item in return. If the return is not possible within a specified period, we must then pay for the item in cash.

The NMSA is implemented by DOD Directive 2010.9, *Mutual Logistic Support Between the United States and Other North Atlantic Treaty Organization (NATO) Forces*, and DOD Instruction 2010.10, *Mutual Logistic Support Between the United States and Other NATO Forces - Financial Policy*, and, for the USAF, AFR 400–9, *Mutual Logistic Support Between the United States Air Force and Other North Atlantic Treaty Organization Forces*. DOD implementation of the program calls for the United States European Command (USEUCOM)

to negotiate "umbrella" cross-servicing agreements with NATO members. to be followed by implementing arrangements negotiated by the USAF and other services with their counterparts detailing specific procedures.

"In general, the new law has been enthusiastically received by our NATO partners."

Status of Agreements

In general, the new law has been enthusiastically received by our NATO partners. The first NMSA umbrella cross-servicing agreement negotiated by USEUCOM signed under the new law was with the NATO Maintenance and Supply Agency in February 1982. Since then, agreements with nine countries and one other international organization have been signed.

The Myths

Because the law is relatively new and its provisions not generally known, there naturally exists a number of misunderstandings (myths) regarding its scope and coverage. In discussions with a number of officials throughout the USAF, it is clear that some expect the law to solve all or nearly all of the needs for a strategy of "coalition logistics" with our NATO partners. On the other hand, some fear the law creates new problems detrimental to true international cooperation. The following analysis covers eight major myths surrounding the law. This discussion should dispel a number of potential misunderstandings.

(1) THE PROGRAM WILL REPLACE FOREIGN MILITARY SALES (FMS) PROCEDURES IN NATO. Congress intended that the law would not be used for routine transfers between the US and other NATO allies. Several controls were mandated in the law to make certain the NMSA would not replace FMS as the normal method for the US government to sell defense articles or services to NATO countries and organizations.[6]

The first control is that the transfer authority does not include major end-items of equipment such as aircraft, tanks, and ships. Only FMS or direct commercial sales are available to accomplish such transfers to NATO members.[7]

Secondly, the US government has a $100 million annual ceiling on what it sells to NATO members under NMSA. This ceiling is subdivided by service ($10 million for the USAF in FY 1983).[8] This relatively modest annual dollar ceiling is far exceeded by the annual FMS transactions with NATO members. For example, during fiscal year 1981, the US government agreed to sell over $2 billion worth of defense articles and services to NATO countries.[9]

Additionally, the law provides a $100 million annual ceiling on what the US government can acquire using NMSA authority. Of that total, a subceiling of $25 million is established for acquisition of supplies other than petroleum, oil and lubricants (POL). These ceilings are also further subdivided by service. For FY 1983, the USAF was allocated an annual ceiling of $8 million to buy non-POL products or services using this authority.[10]

RIK or exchange actions that do not later convert to buy or sell transactions do not count against the established annual ceilings. Furthermore, ceilings would not apply in a wartime situation.[11]

(2) THE NMSA AUTHORITY REPLACES ALL OTHER EXISTING CROSS-SERVICING AUTHORITY IN NATO. For years the USAF has entered into cross-servicing agreements for aircraft fuels with a number of countries throughout the world, including our NATO partners. The authority for the USAF to enter into such arrangements is not altered by the NMSA. In fact, the NMSA provides additional authority and does not replace any authority that now exists. While the cross-servicing of aircraft fuels may be accomplished under NMSA, it is not necessary that its procedures be used when other adequate authority exists. When other authority is being used, the transactions do not count against the NMSA ceiling.

(3) THE US LOSES CONTROL OF ITEMS TRANSFERRED UNDER NMSA AUTHORITY. An important control under FMS is that recipient countries agree to obtain prior US permission before selling or otherwise providing defense articles or services of US origin to third parties. While not explicitly stated in the law, Congress fully intended (as outlined in conference reports) that current restrictions regarding third-party transfers outside of NATO contained in the Arms Export Control Act be retained.[12] DOD and USAF regulations require appropriate controls be established to enforce this requirement.[13]

"This calls for each party to charge prices no less favorable than the prices charged to the armed forces of the supplying country for identical items or services."

(4) PRICING UNDER NMSA IS A UNITED STATES "GIVEAWAY." While the prices charged may, in some instances, be lower than those under full FMS principles, it is far from a "giveaway." All sales by the US are just that—sales, not grants or extensions of credit. With respect to specific prices charged, the law provides for the US to negotiate with other NATO countries to achieve reciprocal pricing principles. This calls for each party to charge prices no less favorable than the prices charged to the armed forces of the supplying country for identical items or services. For items or services procured by the supplying country from a contractor, the price may vary depending upon delivery schedules, points of delivery, and similar considerations.

If agreement cannot be reached on these principles, the US may only acquire the item or service if it determines, after analysis, that the price is "fair and reasonable." If we sell without a reciprocal agreement, FMS pricing principles apply.

Indirect costs (plant and production equipment, administrative surcharges, and contract administration costs) may be waived only if the other NATO country agrees to do so on a reciprocal basis.[14]

(5) PRUDENT PROCUREMENT PRACTICES ARE SACRIFICED. While it is true that nine provisions of contract law are rendered inapplicable under NMSA transactions, Congress fully intended this simply to provide sufficient flexibility to more reasonably negotiate and draft agreements. Compliance with the general principles of prudent procurement practice is still required. This means that, among other considerations, we must continue to obtain fair and reasonable prices for support acquired. By virtue of the law, we have not entered into a "special relationship" with other NATO countries or organizations in which we can acquire any

support regardless of the cost. Again, the impetus behind Congress granting the waivers was the recognition that we would be dealing with NATO governments or subsidiary bodies and not engaged in a government-contractor relationship.[15]

Additionally, AFR 400–9 states that we will not acquire support where alternative sources exist that would be more advantageous to the USAF, price and other factors considered.[16]

As a final note, while nine provisions of contract law were rendered inapplicable under NMSA, other portions not waived remain in effect.

". . . the Atlantic Alliance stands to gain since acquisitions and transfers can be executed faster and easier."

(6) SUPPORT WILL BE "ONE-WAY" FROM THE US TO OTHER NATO COUNTRIES. To ensure the reciprocal pricing principles noted earlier are truly meaningful, it is necessary that the entire program be reciprocal. In other words, we would expect, over time, to receive roughly the same level of support that we provide. While some have expressed a legitimate fear that we may hurt ourselves in some transactions by transferring critical assets, it must be remembered that the law applies only to "Europe and adjacent waters." In some instances, our NATO partners may have more to "lose" because we are much closer to their sources of supplies than they are to ours. In fact, only supplies physically located in the NATO operational area (less North America) at the time the support is requested may be transferred.[17]

Assuming the program is truly reciprocal, in the long run, none of the participating countries or agencies has anything to lose. Most importantly, the Atlantic Alliance stands to gain since acquisitions and transfers can be executed faster and easier. By better distribution of available assets, our overall readiness will be enhanced.

(7) AGREEMENTS REQUIRE RESTRICTION TO RIK. Some have advocated that we not permit sales of items or services by the US but simply demand replacement within a specified period of time because we may be required to "give up" a valuable asset that can take several years to replace through procurement. In other words, some fear we may provide our NATO allies a means to obtain long-lead critical items in short supply that might have otherwise taken months or even years to acquire. To "control" this possibility, some have advocated restricting transactions to RIK or exchange.

While it is true that we may "lose" some critical assets in this manner, it is also true that our NATO allies are subject to the same concern regarding our acquisitions. Further, we provide items or support strictly on a voluntary basis. AFR 400–9 specifies that we may not provide support, if as a result, it would reduce our inventories below that necessary to meet our own requirements or obligations in FMS agreements. Additionally, we may not interfere with or degrade our ability to meet our own requirements or commitments.[18]

Notwithstanding these constraints, there may be times when support is provided by the US involving a critical asset in short supply. However, requiring an RIK transaction is not necessarily a solution for guaranteeing the timely recovery of the item.

At the present time, if we provide an item on an RIK basis, we require that it or an identical or substantially identical item be returned within 90 days. A proposal to extend this period up to one year is likely to be approved in the near future. At the end of the 90 days (or one year if that period is adopted), the transaction automatically converts to a "sale" with reimbursement expected.

For long-lead items, restricting transactions to RIK will not guarantee their return. Assuming the mandated replacement period is reached and the supplied country simply does not have an asset, without the opportunity to convert the transaction to a sale, the replacement period would have to be extended. In the meantime, the USAF is not reimbursed for the asset.

(8) ONE FORM OF LOGISTICS SUPPORT WILL BE EXCHANGED FOR ANOTHER. A very common misconception is that we are permitted to provide support in one manner (aircraft spares), while obtaining the "replacement" in another form (storage services). This is not possible because we can only engage in RIK or exchange transactions that involve "identical" or "substantially identical" items or services. Substantially identical is defined as being equal value and quality of the same kind or type in all material respects (same form, fit, and function).[19]

The Readiness Benefits

There is no question that the NMSA helps us negotiate the acquisition of support through the waiving of certain provisions of contract law. Although this has not been a significant problem for the USAF in the past, the added flexibility should help in future negotiations.

The greatest benefit appears to give additional authority for responsive exchange of critically needed assets for deployment and exercises and to satisfy NMCS conditions for common systems. For example, with a deployment to Europe, the USAF may be able to locally satisfy an NMCS condition with minimum delay without relying on theater or continental US sources.

Overall, our readiness rates should increase. It is difficult, however, to predict just how much without further experience to include appropriate empirical data to properly assess the program.

The Need for Change

While the NMSA is a step in the right direction, several changes should be considered to make it more meaningful and useful.

RIK Transactions

Our flexibility would be increased significantly if we were permitted to enter into RIK or exchange transactions substituting one form of logistics support for another. While most NATO countries are highly industrialized, not all have the same capacities. It is not too difficult to imagine the US providing some technical logistics services in exchange for some other commodity or service within the industrial capability of another partner.

The biggest challenge here, of course, is determining what constitutes "equal" value. While difficult, it would not be an impossible task and such transactions could be of great benefit to both parties. With an amendment to the law, this option could be available to DOD.

Extend the RIK Period

While it seems reasonably assured that the RIK or exchange period will be extended to one year from its present 90 days, it still must be approved by DOD and Congress during the mandatory review of a proposed change to DOD Directive 2010.9.

This change is necessary because 90 days is just not enough time to return some assets. For example, if an ally cannot return an item in 90 days but could do so soon thereafter, converting the transaction to a "sale" at the end of 90 days would foreclose the option of obtaining a replacement item in a timely manner. Extending the RIK period would provide additional flexibility to better manage the program. The one-year period could be treated as the maximum allowable period and not necessarily as the preferred period which could be shorter.

Broaden the Scope of the Law Beyond NATO

There are other regions of the world where we and other allies may benefit from a similar program. For example, during a USAF deployment to a friendly (non-NATO) country having similar weapon systems, we may be able to swiftly tap its logistics reserves (and vice versa) to supplement our forces.

A legislative proposal to expand the NMSA to include the Republic of Korea is now under consideration. Assuming the benefits accrue as envisioned, a selected extension of the law or new legislation, as required, to include other selected allies or friends may be appealing at some time in the future.

The Last Word

Any new program requires a period of time for those involved to gain experience and insight in order to fully understand its scope and limitations. The NMSA is no exception.

The NMSA certainly is not a panacea to solve the logistics problems of or within NATO. In fact, it is a relatively modest and limited step, but it has considerable potential. If understood and properly implemented, it can and will contribute to the readiness of both the US and other NATO forces. While further experience under the law may provide insights to other necessary changes, certain revisions as outlined in this paper should improve the law even as the program is now being implemented.

It is a fundamental principle in NATO that logistics is, in general, a national responsibility. However, strict adherence to this principle ignores the potential benefits of international cooperation that is and will continue to be necessary. The NMSA is an integral part of the international cooperation vital in the NATO environment.

Notes

[1]North Atlantic Treaty Organization Mutual Support Act of 1979, Preamble, Title 10, United States Code, Chapter 138.

[2]Daniels, William G. (retired member of the Staff Judge Advocate's Office, Headquarters, United States Air Forces, Europe). "Acquisition By the United States Armed Forces From NATO Nations and Organizations" (unpublished article, 1980), pp. 1-9.

[3]Interview with Mr. Boyd W. Allen, Assistant General Counsel (International Matters & Civil Aviation), Department of the Air Force, 15 September 1982.

[4]Senate Report No. 96-842, 96th Congress, 2d Session (1980), p. 11.

[5]Ibid.

[6]Ibid., p. 3.

[7]AFR 400-9, *Mutual Logistic Support Between the United States Air Force and Other North Atlantic Treaty Organization Forces* (Washington, DC: Department of the Air Force, 23 April 1982), p. 2 (para 4-e).

[8]Message, United States European Command, Ceiling Allocations for the NATO Mutual Support Act (NMSA), ECJ4/7 150922Z October 1982.

[9]Report, Foreign Military Sales, Foreign Military Construction Sales and Military Assistance Facts As Of September 1981, Data Management Division, Comptroller, Defense Security Assistance Agency, October 1981.

[10]Message, Ceiling Allocations for the NATO Mutual Support Act (NMSA), ECJ4/7 150922Z October 1982.

[11]AFR 400-9, p. 4 (para 6g(3)).

[12]Committee Report, NATO Mutual Support Act, p. 3.

[13]AFR 400-9, p. 2 (para 4j).

[14]Ibid., pp. 4-5 (para 6j).

[15]Senate Report No. 96-842, p. 6.

[16]AFR 400-9, p. 3 (para 4p(2)).

[17]Ibid., p. 2 (para 4g).

[18]Ibid., p. 2 (para 4i).

[19]Ibid., p. 8 (definition 11).

Item of Interest

Institution of Diagnostic Engineers

In recognition of the special knowledge and skills needed for the diagnosis of deterioration of plant and machinery and of the development of faults, the Institution of Diagnostic Engineers has been formed to promote the professional status and personal career prospects of such persons.

The First Annual Convention of the Institution (Advanced Maintenance Techniques/Diagnostic Technology) will be held at the CITY CONFERENCE CENTRE, London, on 4–7 September 1984. Further details are available from:

Institution of Diagnostic Engineers
3 Wycliffe Street
Leicester LE1 5LR, England
(Telephone: 053-759 2552 (Dr. Collacott))

1984 AIRPOWER APS SYMPOSIUM

Trends in Arms Trade with the Third World

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Introduction

Arms trade with the Third World is a vital aspect of international relations. The Third World continues to be the breeding ground for major crises and trouble spots, drawing the interest and frequently the active participation of the two superpowers. Since World War II, over 60 conflicts have occurred in the less developed countries of the Third World.

Arms trade with the less developed nations raises issues concerning the nature of military assistance, growth of military expenditures, opportunities for economic and social development, efforts for restraint and arms control, and competition between the West and the Soviet bloc. This paper discusses the arms trade with the Third World, describes the major suppliers and recipients, and presents several trends for future consideration.

Terminology

There are several difficulties in determining trends in the arms trade with the Third World. One is that there are varying definitions of the "Third World" and different criteria to classify nations as developed or developing. Another involves the term "arms transfers" itself. Some military sales transactions have little to do with the actual transfer of arms. These include training programs, management services, and construction of facilities. Even with an agreed definition, other difficulties include how to quantify arms trade. The most commonly used denominator is price, although price can be affected by quantities ordered, concessions made, and currency exchange rates. As a result, monetary terms do not necessarily reflect the quality of the arms being provided and often do not completely portray the military capability being transferred. Finally, there is much variation in the openness of countries to their arms trade data. A few nations now do report arms sales and other military expenditures data to the United Nations (UN), and from that limited data several observations can be drawn.

The Third World

The term "Third World" refers to those nations not included in the "First World" of the industrial West and the "Second World" of the Soviet bloc. Their primary characteristic is economic underdevelopment. However, the term "Third World" is used, rather than "underdeveloped" or "developing," to change the focus from primarily an economic focus to one also including major political, social, and military aspects. In its reports, the United States (US) State Department includes in the Third World all nations except (a) members of the North Atlantic Treaty Organization (NATO) and the Warsaw Pact; (b) other European countries not belonging to either alliance; and (c) Japan, Australia, and New Zealand (2:55).

The Third World countries share no common language, culture, religion, or race. Many are linked only by such negative factors as economic underdevelopment, a history of colonial rule, distrust of the West, and a goal of ending their world position of inferiority. Most have attempted to remain neutral or nonaligned concerning the global affairs of the two major power groups; however, most of the Third World must obtain political, economic, technical, and military assistance from these two blocs to promote its development.

Arms Trade

Conventional arms trade in the 1970s averaged approximately 1.7% of total world trade. However, for developing countries, arms trade represents a much larger proportion of their imports. During 1976-1980, arms imports of the Third World constituted up to 5.4% of total imports.

Therefore, approximately three-fourths of the world's arms transfers go to the Third World. Its overall cost of arms imports fluctuated, during the decade 1971-1980, from a low in 1971 of $8.1 billion, to a high in 1979 of $20.5 billion (using constant 1979 dollars). Arms trade with the Third World reflects international tension and continuing turmoil in the Middle East, Central America, and other trouble spots, particularly locations where the two superpowers have vested interests. Developed nations have been responsible for the overwhelming amount of the world's arms trade (22:75).

Suppliers

The primary suppliers of weapons to the Third World are the Soviet Union and the US. Approximately two-thirds of the arms exported to the Third World are from these two superpowers. During 1976-1980, the Soviet Union was the major arms supplier to Africa, Latin America, and South Asia, while the US led in providing arms to the Middle East and East Asia.

The Union of Soviet Socialist Republics (USSR) has generally been the largest major ground weapons supplier to developing countries, providing them with tanks, self-propelled guns, light armor, and artillery. It has also made delivery of more military aircraft, particularly supersonic models, than the US. In addition, during 1976-1980, the Soviet Union provided almost twice the number of surface-to-air missiles to the Third World as did the US. In contrast, the US led in the export of naval surface combatants, subsonic aircraft, and other aircraft, such as trainers and transports (22:121).

The Soviet Union though has a smaller number of customers than the US. It is also much less willing to license production

of major weapons. India is the only Third World country licensed to produce major Soviet equipment, while the US has a number of such agreements with different countries. Both superpowers use arms exports for political and economic purposes, although Soviet arms trade with the Third World plays a greater role than does its economic aid. Arms agreements have been used by the Soviets to expand their influence in the Third World.

France is the third largest arms supplier. Although exporting worldwide, its predominant markets are in Africa and the Middle East. The French arms industry is highly dependent on these exports, and the French labor unions encourage arms exports for largely selfish reasons. In fact, the large aircraft manufacturer Dassault-Breguet, France's leading arms export company, depends on exports for 70% of its business.

Following France, the next largest arms exporters to the Third World are Italy, West Germany, and the United Kingdom. Italy's share of the Third World market has continued to grow because of limited government controls over Italian arms manufacturers. Its arms sales are almost exclusively to the Third World, with Libya as its largest customer. However, both West German and British arms sales have been restricted by government policies. The West Germans, for example, are prohibited from selling to areas of tension, while the British government refuses sales of arms to Iran or Iraq while they are at war (21:183-187).

The largest arms exporters of the Eastern bloc, after the USSR, are Czechoslovakia, Poland, and Yugoslavia. Their arms sales are primarily with Africa, the Middle East, and South Asia (22:117-120). Figure 1 shows the distribution of Third World arms trade from 1976-1980.

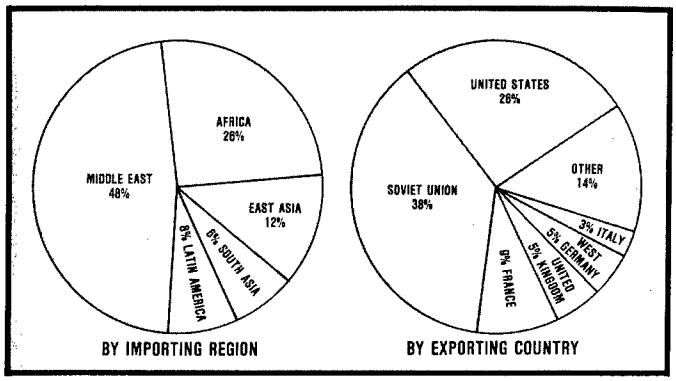

Figure 1. Distribution of Third World Arms Trade, 1976-1980 (22:117-120).

Recipients

The primary recipient of arms trade to the Third World has been the Middle East because of its political turbulence, border fights, religious conflicts, and vast natural resources. Recent events in Lebanon continue to make the Middle East an attractive arms market. Major arms importers in this region include Syria, Iraq, Saudi Arabia, Israel, Jordan, and Egypt.

Africa, predominantly North Africa, has been the Third World's second largest recipient. The bulk of these sales have been to Libya, which imported the second largest dollar amount of arms worldwide in 1980 and was the world's leading importer in 1979. Other major African weapons importers are Algeria, Ethiopia, and Morocco. More than one-third of the Soviet arms trade with the Third World is with African nations, whereas only 4% of US arms trade is to that region.

The next region, following Africa in size of arms imports, is East Asia. This region's largest importers during 1976-1980 were South Korea, Vietnam, Taiwan, Indonesia, and Thailand. As shown in Figure 2, this region receives a major portion of the US arms trade with the Third World.

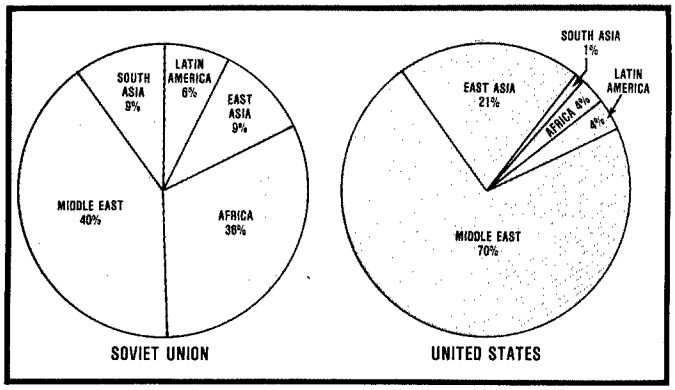

Figure 2. Regional Allocation of U.S. and Soviet Arms Trade with the Third World, 1976-1980 (22:117-120).

The remaining regions, Latin America and South Asia, have relatively smaller arms imports. Cuba, Argentina, and Peru were the leading Latin American arms importers through 1980. As turmoil in Nicaragua, El Salvador, and Cuba continues, greater American military aid to Latin America can be anticipated; however, Soviet sales to Cuba and Peru have surpassed all US arms exports to this region. In South Asia, the principal arms importers have been India, Pakistan, and Afghanistan (22:75-79ff). Table 1 lists the Third World's leading arms importers in 1980.

Third World's Leading Arms Importers in 1980 ($ Million)

(22:80-116)

SYRIA	2,400
LIBYA	2,100
IRAQ	1,600
SAUDI ARABIA	1,400
ISRAEL	825
INDIA	725
VIETNAM	700
JORDAN	525
EGYPT	500
MOROCCO	500

Table 1.

Trends

Level of Arms Transfers

In terms of constant dollars, arms trade with the developing world dropped in 1980 for the first time since 1974. However, arms trade has increased significantly for each region since 1970, except for East Asia, where arms imports declined significantly after the close of the Vietnam conflict. The region with the greatest rate of change in arms trade has been Africa, where arms imports rose from $495 million in 1971 to

$4.45 billion in 1980 (in constant 1979 dollars). This dramatic increase resulted from the huge influx of Soviet weapons to that region. Since 1976, the USSR has provided military equipment to over 20 African countries (22:75ff).

OPEC Arms Trade

A group of countries which has had significant increases in arms imports is the Organization of Petroleum Exporting Countries (OPEC). During 1971-1980, the value of weapons imported by OPEC was up to 8.7% of its total imports. As Figure 3 shows, OPEC members have used their increasing purchasing power to buy more military hardware, services, and facilities as the value of their exports skyrocketed with large oil price raises. In then-year dollars, OPEC arms purchases grew from $581 million in 1971, which was before the oil price increase, to $8.1 billion by 1979. In 1980, arms imports dropped to $7.0 billion, reflecting the general worldwide trend. This huge increase in OPEC arms imports becomes readily evident when a constant dollar comparison is used. In constant 1979 dollars, OPEC members imported arms valued at $991 million in 1971. In that year, their total exports were valued at only $35 billion. OPEC exports grew to $266 billion by 1980, an increase of 837% over the 1971 level. Arms imported in 1980 were valued at $6.3 billion, an increase of 637% during the same period (22:79).

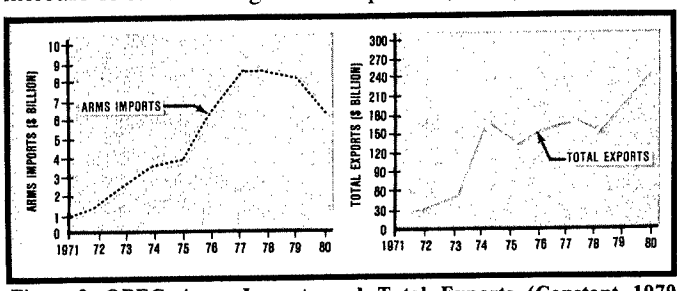

Figure 3. OPEC Arms Imports and Total Exports (Constant 1979 Dollars) (22:79).

As oil prices increased in the mid-1970s, OPEC not only increased its weapons purchases but also its share of the worldwide arms trade. In 1971, OPEC received only 9% of worldwide conventional arms transfers; however, its share grew annually to a maximum of 38% by 1977 and then dropped to approximately 27% in 1980. During the late 1970s, OPEC members also imported almost one-half of the arms transferred to the Third World. During 1976-1980, over 40% of the weapons received by OPEC were from the Communist bloc. Libya, for example, is one of the few countries able to buy the advanced MiG-27 from the USSR. Algeria and Iraq have also received sophisticated Soviet equipment even before Warsaw Pact members (6:47).

Domestic Arms Industries

Many members of the Third World are attempting to build some type of domestic arms industry. The United States Arms Control and Disarmament Agency (ACDA) has reported an increase in the number of Third World countries capable of building or assembling major items of military hardware. In addition, more than 30 Third World nations manufacture arms. Most, however, are limited to producing small arms, ammunition, and small naval vessels (23:1-43).

In addition to obvious economic incentives, Third World countries are motivated by a strong desire to reduce their dependence on the sellers by at least producing their own spare parts. The first step in developing an indigenous production capability is to build repair and overhaul facilities for the maintenance of those imported weapons. India and Israel did this in the 1950s (3:77).

In some cases, domestic arms industries have been developed in the Third World to respond to weapons embargoes. South Africa, for example, began developing its arms industry in 1965 after the UN imposed an embargo on arms transfers to that country. In addition, Taiwan has increased its domestic production.

Several Third World countries, such as Brazil and Israel, are rapidly emerging as important arms suppliers. The Israeli Aircraft Industry was not even created until 1953, yet today it is one of the Third World's most advanced manufacturers. Even the People's Republic of China has been an arms exporter, although it is generally limited to systems of Soviet design, dating back to the 1960s. Beijing has recently been more active in its arms transfers to the Third World and is seeking Western technology to upgrade its production capabilities (2:57-60).

Arms Exports of the Third World

In line with domestic production, Third World countries are entering the international arms marketplace. Figure 4 shows the extent of Third World involvement in the total trade picture. The developing countries promise to become increasingly competitive.

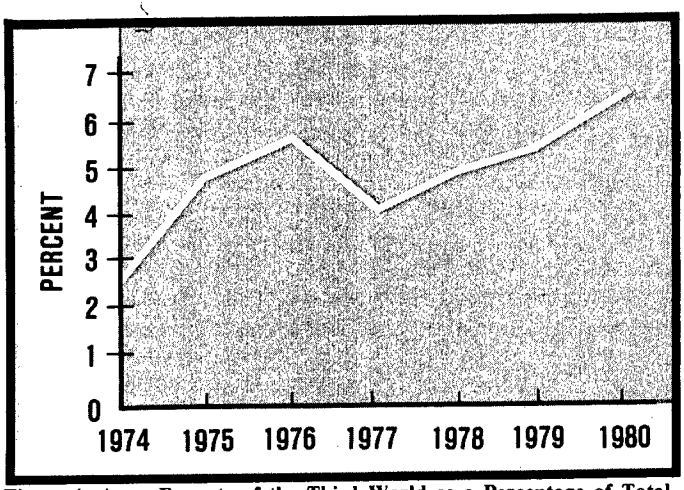

Figure 4. Arms Exports of the Third World as a Percentage of Total Worldwide Arms Exports (22:75).

Restraint

The demand for arms is high, and many suppliers are willing to satisfy the demand. Therefore, unilateral restraint as a basis for arms control has not been successful. The Soviets routinely overproduce for export, and Western Europe is promoting sales in regions once dominated by the US. In the 1960s, when the US restricted its arms sales to Latin America, the purchasers then turned not only to Western Europe and Canada but, in some cases, to the Soviet Union as well. In 1974, Congress finally abolished the ceiling it had placed earlier on arms exports to that region (9:80).

The subsequent efforts of the Carter administration to curb the international arms trade achieved mixed results. Its initiatives were implemented despite past experience which cast doubt on the ability to develop restraint among suppliers and recipients. The State Department was cautiously

optimistic that the Carter policies would help in establishing an approach for multilateral restraint (18:19). However, during the Carter years, while US arms agreements with the Third World were relatively constant, the Soviet Union doubled the value of its agreements over the previous four years. In addition, France tripled its agreements, and West Germany, Italy, and the United Kingdom each doubled theirs (13:76-77).

The difficulty in achieving support for restraint is reflected in the limited participation of nations in a UN program to report military expenditures. In 1980 and 1981, the UN General Assembly recommended that military expenditures be reported regularly to the UN. Some 25 countries have reported these expenditures to the UN at least once since 1980. They include the US, most of its NATO allies, and a handful of Third World countries. However, no nation from the Soviet bloc has yet participated in this reporting program. On 17 June 1982, in an address to the second UN General Assembly Special Session on Disarmament, President Reagan proposed an international conference to develop a common system for accounting and reporting military expenditures. He also urged the Soviet Union to support this proposal and "to revise the universally discredited official figures it publishes." Until nations agree to openly report military expenditure data, their support in restraining conventional arms transfers also must be considered doubtful (22:8-12).

Arms Production and Earnings

Another factor affecting efforts to restrain conventional arms transfers is the expanding use of arms exports to improve production efficiency and provide other economic benefits. Although several nations have domestic arms industries, most do not have a home market large enough to offset development and production costs and, therefore, export their first-line weapons. Greater arms exports have several advantages. These include lower unit prices because of economies of scale, fewer gaps in production lines, higher domestic employment, and a better balance-of-payments position. President Reagan also recognized the contribution of arms exports, when he stated that they can "enhance United States defense production capabilities and efficiency." Items such as aircraft, missiles, vehicles, and communications equipment offer significant potential for savings from greater production because of export sales (23:1-39).

For example, France's own forces are too small a market; and its arms industry, which employs approximately 300,000 persons, is highly dependent on exports for its success. Another leading arms producer which seeks foreign markets for its weapons is West Germany, whose arms industry has operated recently at only 50% of its capacity (21:183-184).

On the other hand, the large production capacity of the Soviet Union that was developed to support its force modernization program has given it several advantages over other arms exporting nations. It has become the world's largest producer of conventional military equipment. As a result, it can deliver significant amounts of weapons quickly, where other suppliers might have to choose between providing new equipment for export or for use by its own forces, thereby possibly losing a sale by not being able to deliver the equipment on time. The USSR has also developed several variations of its newest equipment especially for export and has also kept open the production lines of some items, such as the MiG-21 fighter, which is no longer used to equip priority units. Finally, the Soviets also maintain large inventories of old equipment which can be provided when requested (2:57).

Exports have become an effective method not only for disposing of huge excesses but also for earning hard currency. Through the early 1970s, most Soviet arms agreements were made with low interest rates and were repayable with traditional exports of the recipient. However, since then, the percentage of Soviet arms exports paid for in hard currency has risen considerably. For example, in 1977, the Soviets gained approximately $1.5 billion in hard currency from arms sales. Since then, just the military sales to Libya (which pays for its arms imports in dollars or other convertible currencies) have earned almost $8 billion in hard currency. "Sales for hard currency apparently have largely supplanted the 'arms-for-commodities' trade of earlier years" and will likely continue to be an increasing share of Soviet arms agreements (8:387). In their military posture statement for fiscal year 1983, the Joint Chiefs of Staff (JCS) predicted that the Soviet will continue to use military assistance and arms sales to boost hard currency earnings (24:68).

Technology Transfers

Technology transfers will play an increasing role in arms transfers to the Third World. These transactions can be "one-way transfers" where a country is given the technology to produce an item for its own use of "collaborative ventures" and expertise is provided as part of a coproduction agreement for a weapon to be used by both countries.

Technology transfers have been accepted as a "fact-of-life" condition of the arms business by some producers who would rather coproduce an item than lose a sale. For example, before Brazil agreed to buy 42 F-5E aircraft in 1975, it demanded that the producers provide some of the aircraft's subsystems. Such demands will continue to multiply as domestic arms industries in the Third World mature. Examples of major US coproduction programs with the Third World in 1982 are listed in Table 2 (12:68-83).

Finally, such technology transfers are not limited to the US. As early as 1962, the USSR signed a license agreement that permitted India to produce Soviet aircraft engines and, in 1966, India began producing MiG-21 aircraft under a similar arrangement (20:285-287).

ITEM	U.S. PRODUCER	OVERSEAS PRODUCERS
F-5E Aircraft	**Northrop**	**Taiwan, South Korea**
500MD Helicopter	**Hughes**	**South Korea**
F-16 Aircraft Components	**General Dynamics**	**Israel**
Turbojet Engine	**Pratt and Whitney**	**Israel**
AN/TPS-63 Radar	**Westinghouse**	**Egypt**

Table 2.

Objectives

Another trend has been the continuing use of military exports to achieve political as well as military objectives. The role that security assistance plays in promoting US national objectives was highlighted in 1981 when President Reagan stated that it is an "indispensable component of foreign policy." He said that arms transfers improve US military effectiveness and force projection, demonstrate interest in a region, strengthen mutual security relationships, and support the preparedness of allies (23:1-38).

The US has also used arms transfers to influence policy changes on the part of recipients. For example, the Carter administration attempted to use security assistance programs particularly to support its human rights goals. A ban on US arms sales and military aid was imposed on Argentina in 1977 because of its poor human rights record. It was finally lifted by the Reagan administration on 10 December 1983, when Argentina's new civilian government was inaugurated (10). In a similar case in late 1983, when Vice President Bush visited El Salvador, he offered to substantially increase military aid, including helicopters, if actions were taken against assassination teams; but he also warned that military aid would be reduced if such actions were not taken "very quickly" (14).

Perhaps the most prominent use of arms transfers to the Third World thus far in the 1980s by the US to achieve national objectives and increase US influence involves potential sales to the Chinese. Arms trade has been a potential avenue for improving Sino-American relations since 1981 when Alexander Haig, then the Secretary of State, announced in Beijing that the US was willing to sell defensive weapons to the People's Republic of China (PRC) on a case-by-case basis. Although China expressed interest then in 65 items, further discussion was postponed because the Chinese objected to continuing US arms sales to Taiwan. However, in September 1983, during Secretary of Defense Caspar W. Weinberger's visit to the PRC, arms transfers were a major agenda item. The US had recently reclassified the PRC as a "friendly, non-allied" country, and Weinberger announced that the Chinese had a "genuine interest" in purchasing antiaircraft weapons, tank defense weapons, and other equipment to modernize its forces (25).

The Soviets have consistently used arms transfers to the Third World to achieve several objectives—to undermine Western influence, to establish a Soviet presence, to extend the Soviet defensive perimeter, to support Third World clients and allies, to preempt Chinese influence, to support insurgencies, to encourage domestic communist movements, and to provide economic benefits for the Soviet economy. Soviet arms agreements have been used to gain influence in a region as the initial means of developing other contacts which would have been difficult otherwise to achieve. The growth of the Soviet navy and the desire to acquire facilities throughout Asia and Africa have also influenced Soviet arms transfer policy. Several Soviet arms sales have been used as a "bargaining" factor in Soviet attempts to establish Third World access (1:49-52).

Arms Exports and Economic Aid

Military support has become the most important element in Soviet relations with most Third World countries. As Soviet economic aid to developing nations has declined recently, greater emphasis has been placed on continuing and increasing military assistance programs. In sharp contrast, Western arms exporters have provided much more economic than military assistance to the Third World, while the Soviet Union exported military equipment to the Third World during 1976-1980 that was more than four times the value of its economic assistance, as shown in Figure 5 (22:31-32).

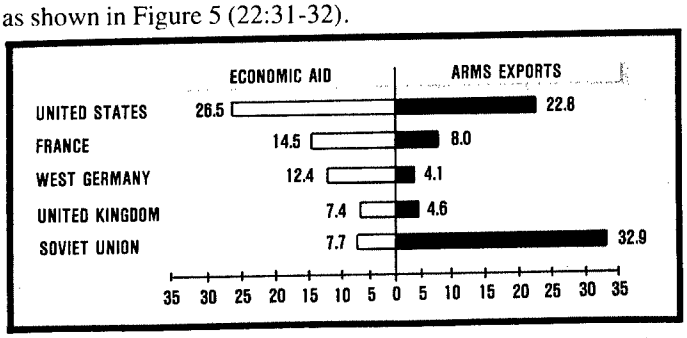

Figure 5. Value of Economic Aid and Arms Exports to Developing Nations During 1976-1980, Cumulative (22:32).

The increased use of military assistance has been beneficial to the Soviets. It has helped make some Third World members dependent on the USSR for their own national security. The Soviets have also sent advisers and technicians with the equipment being sold which has served to maintain a Soviet presence. In addition, arms sales have been used to obtain hard currency as noted earlier. Since the Soviets have had limited success in exporting their political and economic systems, they will probably continue the trend to push military assistance rather than economic aid (8:344-347).

Soviet Use of Surrogates

The last trend to be discussed concerns another aspect of Soviet involvement in the Third World. Excluding its forces stationed in Eastern Europe and the 95,000 Soviet personnel fighting in Afghanistan, the USSR has approximately 20,000 military personnel abroad serving in Cuba, Africa, the Middle East, and Vietnam. To further assist Soviet efforts in the Third World, Cuba provides approximately 34,000 troops which are based in Africa, the Middle East, and Latin America. In addition, East German forces are also being used to supplement Soviet forces in selected Third World locations (19:9).

Senior leaders of US military, national security, and intelligence organizations have warned about Soviet use of surrogates. The Joint Chiefs of Staff (JCS) have forecasted that the Soviets will continue to use military assistance by surrogates to gain influence in Third World countries (24:68). In 1982, Judge William Clark, National Security Adviser, said that the Soviet Union "complements its direct military capabilities with proxy forces and surrogates with extensive arms sales and grants by manipulation of terrorist and subversive organizations, and through support to a number of insurgents and separatist movements—providing arms, advice, military training, and political backing" (22:9). In addition, William J. Casey, Director of the Central Intelligence Agency, has stated that Soviet strategy in Third World countries will be carried out "by another Third World state—Libya, Vietnam, Nicaragua"—and that Soviet involvement will be concealed (4).

The most recent evidence of this strategy was the discovery in late 1983 of Soviet efforts to build the eastern Caribbean nation of Grenada, with a population of 110,000, into a fortress with a military force of 7,000 to 10,000 personnel. Military agreements that the Marxist government of Grenada

had signed with the Soviet Union, Cuba, and North Korea would have permitted the placement of thousands of Soviet bloc infantry weapons, rocket launchers, and artillery pieces as well as 900 personnel from the Soviet Union, Cuba, and other communist nations as advisers in that tiny country (5).

These Soviet actions will create greater demands in turn for counterbalancing Western military assistance. In 1983, Fred C. Ikle, Under Secretary of Defense for Policy, emphasized that a major element of US Caribbean strategy had to involve military aid to defeat guerilla forces creating violence (11:13). The National Bipartisan Commission on Central America (Kissinger Commission) proposed substantively more economic and military assistance for the Caribbean when it made its recommendations in 1984 (15).

Finally, the USSR is also in a position to orchestrate the arms exports of its allies. Weapons design and production in the Warsaw Pact are standardized by the Soviet Union to a degree not found in the West. Pact countries are allocated major items to produce for Pact forces and also for export. This not only provides compatibility with Soviet equipment, but it also broadens the Soviet's arms production and supply base so it can be used in cases where the Soviets do not want to be the direct supplier for political purposes, such as the Iran-Iraq war (2:57).

Conclusion

Conflicts and crises in the Third World will continue to affect the national security interests of the West and the Soviet bloc. To maintain influence in developing countries and access to their resources, the two power groups will continue to provide arms, often making their current weapons technology available. In addition to imports from the developed countries, the Third World will be able to obtain more weapons, many advanced, indigenously because of its expanding arms industries whose further development is encouraged by technology transfers and policies to export greater quantities of military equipment.

Other trends in arms trade with the Third World include the recurring use of military assistance by the developed nations to achieve strategic objectives and promote political, economic, and other national interests. Finally, increased use of surrogates by the USSR and Soviet reliance on military aid to gain influence in the Third World will affect security assistance policies of the West. For security assistance policies and programs to be effective, they must be based on an understanding of these conditions and trends.

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Most Significant Article Award

The Editorial Advisory Board has selected "Logistics Research—'The Unsilent Partner' " by Colonel John C. Reynolds, USAF, and Major Fred G. Saliba, USAF, as the most significant article in the Spring issue of the *Air Force Journal of Logistics*.

CAREER AND PERSONNEL INFORMATION

Civilian Career Management
Career Plans

Where are the jobs? What jobs are available? What jobs will become available? These are questions commonly asked the PALACE Team which manages the Logistics Civilian Career Enhancement Program (LCCEP) at Randolph AFB, Texas. Information about trends in LCCEP can be important to an individual's career plans.

The LCCEP centrally manages approximately 1,800 positions in the logistics community from grades 12 through 15. Plans are to include Transportation occupational series positions, starting at the 09 level, effective 1 October 1984. Currently, all of the GS/GM-14s/15s, 50% of the GS/GM-13s, and approximately 25% of the GS-12s are in the program which is composed of Career Essential, Cadre Reserve, and Career Broadening positions. Registration in the logistics program is open once a year.

Where are the LCCEP positions? What occupational series (OCSRS) are available? When will the jobs be vacated? The following series of charts are designed to portray general information on program trends.

Chart 1-1 presents the number of positions in each command. The Air Force Logistics Command (AFLC), with over 76% of the positions, provides the largest number of job opportunities.

LCCEP POSITIONS BY COMMAND

CMD	*NUMBER OF PROGRAM POSITIONS*	*% OF LCCEP*
HQ USAF	47	2.6%
AFLC	1359	76.5%
AFSC	122	6.9%
ATC	35	2.0%
MAC	59	3.3%
SAC	22	1.2%
TAC	21	1.2%
OTHER COMMANDS	112	6.3%
TOTAL	1777	100.0%

Chart 1-1.

Chart 1-2 shows jobs at HQ AFLC, each Air Logistics Center (ALC), the Aerospace Guidance and Metrology Center (AGMC), and other AFLC facilities. HQ AFLC alone has 20.5% of the total program opportunities.

AFLC LCCEP POSITIONS

LOCATION	*NUMBER OF PROGRAM POSITIONS*	*% OF TOTAL LCCEP POSITIONS*
HQ AFLC	364	20.5%
OC-ALC	226	13.0%
OO-ALC	129	7.0%
SA-ALC	212	12.0%
SM-ALC	139	8.0%
WR-ALC	179	10.0%
AGMC	50	3.0%
OTHER AFLC FACILITIES	60	3.0%
TOTAL	1359	76.5%

Chart 1-2.

In addition to location considerations, a look at job availability in specific OCSRS is also prudent in career planning (see Chart 1-3). As expected in a logistics program, logistics management (346 series) at 35.9% encompasses a major segment of the positions and promotional competition in this series is most intense. To compete as the most highly qualified in any of the logistics series, an individual must pass all the Progression Level Factors in the applicable Promotional Evaluation Pattern (PEP). Questions on PEPs can be answered by your servicing CCPO or the counselors at the Office of Civilian Personnel Operations.

LCCEP POSITIONS BY OCSRS

OCSRS	*NUMBER OF PROGRAM POSITIONS*	*% OF PROGRAM*
301	161	9.1%
345	137	7.7%
346	638	35.9%
1101	112	6.3%
1910	110	6.2%
2003	188	10.6%
2010	146	8.2%
2130	109	6.1%
OTHER LOG SERIES	176	9.9%
TOTAL	1777	100.0%

Chart 1-3.

Chart 1-4 shows the percentage of people in LCCEP positions that will be eligible to retire in 1984. In the past, 25% of the eligibles retired in a given year; however, potential changes to the retirement system are likely to cause an even greater than normal migration to retirement. How does this affect other currently employed personnel? Opportunities abound for those at the right place, at the right time. The key is mobility.

LCCEP POSITIONS WHERE INCUMBENTS WILL BE ELIGIBLE TO RETIRE IN 1984 (PERCENTAGE)

OCSRS	*GRADE 12*	*13*	*14*	*15*
301	12.0%	18.0%	15.5%	19.3%
345	14.6%	17.0%	11.4%	20.0%
346	13.5%	16.7%	18.4%	31.9%
1101	30.3%	16.2%	2.9%	14.3%
1910	13.8%	23.7%	28.6%	---
2003	25.5%	22.4%	48.0%	25.0%
2010	10.8%	12.8%	18.9%	---
2130	24.1%	19.1%	25.0%	100.0%

Chart 1-4.

Using a statistical base, the overall picture is one of increasing opportunities in logistics career fields. In seeking and accepting lateral/career broadening assignments, one must find out what is required to be highly qualified for specific jobs. An individual's mobility, career experiences, and performance rating all interact as conditions for opportunities in job referral and selection.

Source: Linda Willett, OCPO/MPKCL

Editor's Note: The Military Career Management department does not appear in this issue due to a lack of good, relevant material. The Contributing Editor promises to return next issue.

The World of Islam

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Major civilizations of the world are defined by a subtle combination of geographical area, language, ethnic kinship, and religion. Islamic civilization, as the name suggests, is defined more by religion than any other factor. Islam means "submission to God," or perhaps more precisely, "submission to Allah." Allah is the Arabic word for "the one God." The basic creed of Islam is deceptively simple: *There is no God but Allah and Muhammad is his messenger.*

Followers of Islam, those who have "submitted to Allah," are called Muslims (often spelled Moslems). For Muslims, the God worshipped by Christians and the Jewish Jehovah, or Yahweh, is the same all-powerful deity called Allah by the Arabs.

Today Islam is one of the world's major religions. Nearly 700 million Muslims are spread across the face of the globe. Islam, born in the seventh century after Christ, was hardly a brand new religion or a completely new civilization. It built upon earlier religious traditions of the Middle East, especially Judaism and Christianity, yet it evolved its own uniquely Arab character. It is hardly a coincidence that all three of these major world religions worship the same God.

The Muslims share more than just religious ties with the West. Americans and Europeans enjoy a civilization which can trace its origins back to the classical Greeks and ancient Hebrews. The people of the Middle East, like those in the West, can trace the roots of their civilization to the ancient world. In fact, the civilizations of the West and of the Middle East share a common heritage which did not clearly separate until after the collapse of the Roman Empire.

There is general agreement that the civilization of the Roman Empire, centered on the Mediterranean Sea, ended sometime between 400-700 A.D. Three new civilizations, heirs to the Roman Empire, arose on three sides of the Mediterranean: Western European Christendom on the north; Byzantine Christendom (and later, Russian) on the eastern shore and to the northeast; and Islamic to the south and southeast.

From the beginning, the Byzantine Empire had to fight to protect its Anatolian heartland and provinces in Syria, Palestine, and Egypt. The chief antagonist—before Islam—was the Persian Empire, Zoroastrian in religion and anti-Greek in feeling. Persia and Byzantium fought each other practically to exhaustion. In the seventh century A.D., when Muslims from Arabia looked north for new lands to conquer, the whole Middle East, weak from constant warfare and imperial struggles, lay open before them.

The European civilization, the Byzantine Empire, and the civilization of Islam fell heir to the ancient Roman Empire. Of these three, the spectacular conquests and achievements of Islam were the most remarkable. Within a century of Muhammad's death, a handful of Arabs from the most desolate part of the Middle East with an infant religion forged an empire stretching from the Pyrenees in northern Spain, across northern Africa, through Egypt, Arabia, the Fertile Crescent, and Persia, as far as the Indus River in South Asia and beyond the Iranian plateau into Central Asia. The search for an explanation of this amazing development must begin with the prophet Muhammad and the religion he founded in the Arabian desert.

Muhammad the Prophet

Some of the details of Muhammad's life and activity are important for understanding Islam because the early experiences have frequently defined for Muslims the proper way to live. Islam is more than just a religion; it is a whole way of life. The West has developed a clear distinction between the spiritual and temporal spheres. Westerners have a historical tradition of separation of church and state. For devout Muslims, there is no such separation. "Submission to Allah" means both the now and the hereafter are emanations of God's will.

Muhammad was born in Mecca around 570 A.D. Mecca was a commercial entrepot between great civilizations astride the caravan routes linking the Indian Ocean and Byzantium. Thus Mecca enjoyed a prosperous economy based on trading. The nomadic Arabs lived in the surrounding desert by herding animals, raiding caravans, and waging war on one another. Political and social organization revolved around tribes led by leaders (sheiks) who were elected by others in the tribe or clan.

Meccan trading relationships paralleled tribal organization brought from the desert. Various tribes and clans competed with one another for trading advantages and control of wealth. Mecca flourished not only as a trading center but as a religious center as well; the Arabs' animistic pagan religious beliefs were focused on Mecca—even before Islam—where a great shrine, the Kaaba, held the pagan gods and artifacts worshiped by the Arabs.

Little can be known for sure about Muhammad's life. We think he probably had contact with Jewish and Christian traders who may have helped to shape his religious beliefs. We know Muhammad married a wealthy widow, which gave him a respected place in Meccan society. And yet he was different from the men of his class, frequently spending time in quiet meditation in the hills outside Mecca. During one of these periods of meditation, he experienced a vision and a voice commanding him to "recite." Over the next decade, Muhammad received the Koran, the word of God, and preached the message revealed to him by Allah.

In the year 622, after his preaching had alienated and threatened most of the Meccans, Muhammad and his small group of followers emigrated to Medina, some 200 miles north of Mecca. This event marks the beginning of the Muslim calendar. In Medina Muhammad assumed a position of leadership in the community of believers. He was at once the religious, political, and military leader, and judge of disputes. As Muhammad made decisions concerning the proper

arrangements for Muslim community life, a collection of "traditions and sayings" grew up around him which, as a second material source of revelation, helped define Islam.

After a series of famous battles with surrounding tribes and with the Meccans, Muhammad and his Muslims grew so powerful they were able to enter Mecca without resistance. Idols and pagan gods in the Kaaba were smashed. Mecca accepted Islam and by virtue of the consecration of the Kaaba to Allah became the holiest city of Islam. By the time of Muhammad's death in 632, the Muslims controlled the rich trade routes through Arabia and had conquered or made alliances with the desert tribes. Muhammad was undisputed ruler of Arabia.

"Muhammad is seen simply as the last of a series of prophets which include Abraham, Moses, and Jesus."

Muhammad never claimed to be anything but a prophet. Unlike Christianity, Islam does not revere its founder as divine; Muslims do not worship Muhammad. Muhammad the prophet was God's messenger; he was not God. It is therefore incorrect to call followers of Islam "Muhammadans." Muhammad is seen simply as the last of a series of prophets which include Abraham, Moses, and Jesus.

Muslim religious obligations can be summed up as the five "pillars" of Islam: (1) believing in the one true God and acknowledging Muhammad as his messenger; (2) praying five times a day facing Mecca; (3) giving alms to the poor and needy; (4) fasting from dawn to sunset throughout the month of Ramadan, ninth month of the Islamic lunar calendar; and (5) making a pilgrimage to Mecca at least once in a lifetime if at all possible.

The Islamic Empire

Muhammad's death raised great problems for Islam. The Bedouin tribes dissolved their alliances with Islam as the Muslims struggled with the question of Muhammad's successor. His followers soon proclaimed his close friend and advisor, Abu Bakr, as *caliph,* meaning deputy or successor. Under Abu Bakr, Islam rapidly reconquered Arabia and then found the Middle East ripe for conquest. Arab armies were aided by Islam's tolerant attitude for other "people of the Book," Jews and Christians. Islam demonstrated a tremendous capacity to absorb people of many races, many ethnic backgrounds, many languages, and many religious backgrounds. The Arabs soon conquered Syria, Egypt, and—within ten years of Muhammad's death—Persia itself. By the year 750, the Islamic empire stretched from northern Spain to the Indus River.

In the meantime, a change had taken place in the theory and practice of egalitarian Islamic governance. Powerful generals and governors in far-off provinces challenged the caliphs from Arabia. The governor of Syria succeeded in his claim to be caliph and established his capital in Damascus, thereby decisively shifting the center of Muslim power to the historical heartland of the Middle East from the desert periphery. The new caliph adopted the policy of dynastic succession rather than election, another significant change from earlier tradition. The new dynasty (the Umayyads) relied upon a ruling class of Arabs to administer a far-flung empire in which the Arabs were but a small minority among Syrians, Egyptians, Berbers, Persians, and many others.

Resentment against the ruling dynasty and the Arabs led to overthrow of the Umayyads in the eighth century and its replacement by a dynasty which claimed to treat all Muslims more equally. Under the Abbasids, whose capital was relocated in Baghdad, the "Arab" empire truly became an "Islamic" empire. The Abbasid dynasty ruled (at least in theory) most of the Muslim world for 500 years (750-1258). During this time, Islamic civilization reached its high point in wealth, learning, and power. The elegance and sophistication of Islamic civilization easily eclipsed the crude semi-barbarian culture of early medieval Europe. The caliphate took on oriental trappings of an eastern potentate in splendor far removed from the simplicity of the prophet's life in Arabia.

The strengths of Islamic civilization were apparent in its philosophy, architecture, medicine, science, mathematics, and literature. Great schools of translation rendered Hindu mathematics, Greek philosophy, and Persian science into Arabic. The piety of Islam complemented a vibrant adaptability which drew upon the achievements of practically the entire known world.

The achievement of the Islamic empire was hardly political unity, which began to disintegrate almost as soon as it was established. The real achievement was the "arabization" of the rich and varied civilization of the Middle East. Arabic came to prevail as the common language of the empire, supplanting native languages in Spain, northern Africa, Egypt, Palestine, Syria, Iraq, and even parts of Persia. The term "Arab" became less precise. Rather than specifying a Bedouin from the Arabian peninsula, the term referred loosely to anyone who spoke Arabic and accepted Islam.

The pattern of religio-cultural unity and political diversity characteristic of the medieval Islamic empire has remained an enduring feature of Islam to our own time. Islamic Spain was never within the grasp of the Abbasid caliph. In the tenth century a descendant of the Umayyad dynasty proclaimed himself to be the true caliph, and ruled Spain. At the same time, a third "true caliphate" was set up in Egypt where descendants of Muhammad's daughter Fatima rejected the legitimacy of the other two caliphs. Meanwhile, the caliph in Baghdad had fallen under the influence of Seljuk Turks from central Asia who had accepted Islam and had become a praetorian army of the caliphate. The caliph, by the eleventh century, had only a ceremonial role; he was the puppet for the Turks. Finally, in the thirteenth century, Genghis Khan and his Mongol successors swept through Persia and Iraq. Baghdad was plundered, the countryside was ravaged, and the caliph was murdered. The Arabo-Islamic empire came to a violent end.

Political disunity mirrored religious controversy in the Islamic world. The two main branches of Islam evolved in part because of quarrels and "civil wars" between rival caliphs. The *Sunni* Muslims, sometimes called "orthodox," comprising 85% of Islam today, believed the caliph should be elected as Arab sheiks had been chosen. The Shiites believed the caliphate should be held by blood descendants of the prophet Muhammad, specifically through his daughter and her husband Ali. ("Shiite" comes from an Arabic word meaning "partisans of Ali.") The Shiite party gained supporters among opponents of the Umayyad dynasty. Persians, in particular, embraced the minority religious position in order to resist Arab-dominated Sunni orthodoxy.

Today, there are still some differences in theology between Sunnis and Shiites. The mainstream Shiites believe that caliphs (called imams by the Shiites) are divinely inspired, the

"Iran, the major stronghold of Shiism today, provides a graphic example of strong religious leaders and a highly emotional version of Islam."

twelfth of which, after Ali, will return to right the wrong of the world, while the Sunnis argue that Muhammad was the last prophet and his successors are not divinely inspired. The Shiites have a more hierarchical structure of religious leadership. Iran, the major stronghold of Shiism today, provides a graphic example of strong religious leaders and a highly emotional version of Islam.

The era of the Islamic empire saw the evolution and refinement of Islamic law (the sharia). In simple terms, Islamic law drew its precedents from the following sources: the Koran; the "Traditions and Sayings" of Muhammad; consensus of the Muslim community; and ecclesiastical judgments. More conservative Muslims, such as the Saudis today, accept only the first two of these sources of law. Islamic law defined a whole way of life. Ethics, politics, economic relationships, family life, social arrangements, religious belief—all are connected intimately in one package of "law." This notion of law is very different, obviously, from Western concepts.

Rise of the Ottoman Empire

Between the thirteenth-century Mongol invasions and the First World War, the Ottoman Empire rose as the successor state to the earlier Arabo-Islamic empire. Turkish tribes had long filtered into the Middle East from Central Asia. One of these, originating in northwest Anatolia (Asia Minor), reaching prominence under a certain Osman in the early fourteenth century, achieved greater success than others. Despite setbacks over the next several generations, the house of Osman (the Ottomans) successfully created the greatest and longest lasting Muslim state in the Middle East. The Ottoman Empire grew by leaps and bounds in the fifteenth and sixteenth centuries and replaced the Byzantine Empire as the power in the Eastern Mediterranean, the Balkans, and the Middle East. In 1453, Constantinople was captured and renamed Istanbul.

The Turks, converted to Islam while retaining their strong loyalty to chieftains and their prowess in war, fought fiercely for the glory of Islam. Ottoman political theory, at least in the early years, was simple: "No government without an army, no army without money, no money without subjects." The Ottoman Empire expanded throughout the Arab world and into the heart of Europe. The conquest of Christian lands extended to the very gates of Vienna in Austria. Islamic in religion, Turkish in administration, and martial in character, the Ottoman Empire was the wonder of the age.

The result of conquest was an empire composed of a diverse variety of peoples. The Turks predominated in Anatolia, the area of present-day Turkey. Only here did the Turkish language take hold. In the Balkans and in the Arab provinces, the Turks were present only as rulers. The Ottoman Empire took full account of religious and ethnic differences within the empire. Various "millets," or religious communities, were organized in the empire. Jews and Christians lived in relative freedom within their own millets. The toleration shown to religious minorities certainly compared favorably to the bigotry and intolerance of Europeans in the same period.

Ottoman institutions and Ottoman military might impressed the empire's foes, and with reason. The Ottomans developed a powerful army and navy, an imperial administration, and an extensive legal system. It is curious to us, perhaps, that most of the high officials in the administration were technically "slaves." Many, if not most, were Christian boys from the Balkans, forcibly brought to Constantinople and converted to Islam, who were responsible only to the Ottoman sultan. These "slaves," subject to a thorough training and indoctrination program, had the most privileged positions in the sultan's administration and in the military.

The major source of Ottoman military strength was the infantry corps made up of these slaves. The famous "janissaries" were the backbone of the empire in its heyday and a major problem during the period of decline which set in after the sixteenth century. After the seventeenth century, the janissaries often made and deposed sultans; the fighting corps had become more concerned about their pay and privileges than their training and fighting ability. The corruption and decay which infected the janissary corps, unfortunately, touched every element of the Ottoman administration.

"The medieval Islamic world provides an excellent example of a dynamic culture which reminds us that 'traditional' does not necessarily mean 'backward' or 'static.' "

The attempt to reform in the nineteenth century was a response to the expanding western imperial system in the traditional Muslim heartland. The once mighty Ottoman Empire needed to emulate the West in order to defeat the European enemy. It was not able to do that; by the end of World War I, the empire no longer existed and European states "protected" much of the Middle East.

The medieval Islamic world provides an excellent example of a dynamic culture which reminds us that "traditional" does not necessarily mean "backward" or "static." Traditional Islam's greatest strengths were adaptability and flexibility, coupled, perhaps, with the appeal of religious simplicity. Islam must have been a breath of fresh air for people weary of the hairsplitting and obfuscation of Greek Christendom. The major cultural features of the civilization of Islam were defined and established in the period of the Islamic empire. An understanding of these features is vital in order to comprehend the contemporary Middle East as it struggles to adjust to the forces of modernization.

Editor's Note: Recent history is readily available to all of us—ancient history is harder to locate but can be more repressive on our consciousness. Because the Middle East is now, and will continue to be, a critical center of attention, we logisticians need to know as much as possible about both the ancient and recent past of that area. *The DISAM Journal* has carried several good articles on the recent Middle East. We logisticians need to be aware of our world.

"The first prerequisite for any regular logistic system is, of course, an *exact* definition of requirements."

Martin Van Creveld in *Supplying War*

CURRENT RESEARCH

Air Force Human Resources Laboratory FY84-85 Logistics R&D Program

The Air Force Human Resources Laboratory, Logistics and Human Factors Division, Wright-Patterson AFB, Ohio, is the principal organization which plans and executes the USAF exploratory and advanced development programs in the areas of: (1) Combat Logistics, (2) Acquisition Logistics, and (3) Team Training Systems. Most of the Laboratory's efforts to improve Air Force logistics are managed within these sub-thrust areas. Some efforts are undertaken in response to technology needs identified by the Laboratory, but the majority of the work is in response to formally stated requirements from various commands and staff agencies within the Air Force. Many of our projects vary from basic research aimed at producing new fundamental knowledge to applied projects which are intended to demonstrate the technical feasibility and military effectiveness of a proposed concept or technique.

Following are some logistics R&D projects being managed by the Logistics and Human Factors Division, which will be active during FY84 and FY85 (Contact: Colonel Donald C. Tetmeyer, AUTOVON 785-6797/3713; (513) 255-6797/3713).

DEMONSTRATION OF A UNIFIED DATA BASE FOR LOGISTICS INFORMATION
OBJECTIVE: To develop, demonstrate, and test a computerized unified data base (UDB) of logistics information, and the associated User's Guide and Maintenance Update Handbook to support the weapon system design process.
APPROACH: UDB technology developed under an exploratory development program will be demonstrated and tested on a major weapon system program in this advanced development effort. Interfaces with computer-aided design, weapon system testing, and product performance feedback will be developed and evaluated. The B-1B and a Life Support System will be used as test vehicles.
(Robert N. Deem, LRA, AUTOVON 785-3871, 513-255-3871)

MAINTENANCE AND LOGISTICS MODELS FOR COMPUTER AIDED DESIGN (MLCAD)
OBJECTIVE: To produce tested analytical models, data bases, and procedures for including maintenance and logistics factors within the computer aided design (CAD) process. A biomechanical model of the maintenance technician will be developed which will enable designers to evaluate maintainability during initial design.
APPROACH: Maintenance and logistics (M&L) factors relevant to CAD will be identified and associated with the various design phases of weapon system acquisition. Several representative factors will be selected for integration with CAD. Computer-based analytical models will be developed for selected factors. An existing biomechanical model will be selected and adapted to represent a maintenance technician. Data bases will be developed to support use of the models in a design environment.
(Alan E. Herner, LRA, AUTOVON 785-3871, 513-255-3871)

MAINTENANCE PERSONNEL REQUIREMENTS FOR DISPERSED OPERATIONS
OBJECTIVE: To develop analytic techniques capable of evaluating the impacts of broadened job/task responsibilities for aircraft maintainers on combat performance in dispersed, small unit operations and on manpower, personnel classification, and training policies.
APPROACH: Alternative assignments of identified combat maintenance tasks will be evaluated through simulation. Criteria for reassigning tasks to overcome manpower shortages or to create resiliency in deployed units will be tested through innovative extensions of occupational/task analyses applied to existing maintenance specialties. The feasibility of specialty consolidation will be evaluated through a model that can balance costs of changes to job structures aimed at creating skilled generalists against risks of sortie loss in dispersed operations under the current specialist system.
(Edward Boyle, LRC, AUTOVON 785-3771, 513-255-3771)

MAINTENANCE LIMITATIONS IN A CHEMICAL ENVIRONMENT
OBJECTIVE: To develop and validate methodology to determine how the performance of critical, combat maintenance tasks is impacted by a chemical warfare environment. The methodology will be developed, then tested and applied in a simulated field, chemical environment. The data collected shall also be used to input combat models being developed by the Air Force Aerospace Medical Research Laboratory (AFAMRL). All performance limitations observed will be isolated, identified, and re-examined. Suggested workarounds, policy and procedure changes, and equipment/clothing redesigns are expected to result from this work.
APPROACH: Initial research design and data collection methodology is being developed in-house. During Phase I, final methodology will be tested with data collection results sent to AFAMRL for modeling inputs. Phase II will concentrate on and isolate specific performance limitations discovered during Phase I. These limitations will be further tested for a more exact isolation of the causes to determine the effects on combat sortie generation. Phase III will bring together the data collected in Phases I and II for an extensive analysis. Limiting factors, workarounds, and recommendations for present and future concern will be submitted through this Phase.
(Capt John Duhamel, LRC, AUTOVON 785-3771, 513-255-3771)

AUTOMATED MAINTENANCE PERFORMANCE AIDS
OBJECTIVE: To develop and evaluate prototype automated aids for presentation of technical information for use by maintenance technicians through automation to allow selective data display tailored to individual skill and experience as well as to provide rapid and reliable update.
APPROACH: A series of small design studies will be accomplished to establish system requirements for factors such as display resolution, data presentation formats, and the man/machine interface. Emphasis will be placed on developing systems which are easy to use, provide all the information that the technician needs, and increase the technician's capability to perform maintenance. The system will be field tested by installing a prototype technical data system in an intermediate level shop by Dyess AFB, Texas.
(David R. Gunning, LRC, AUTOVON 785-2606, 513-255-2606)

INTEGRATED MAINTENANCE INFORMATION SYSTEM (IMIS)
OBJECTIVE: To develop an integrated information system for the flight-line maintenance technician which will provide all the diagnostic, technical order, training, and work management data needed for job performance.
APPROACH: A series of design studies and prototype field tests will be conducted to establish the display formats, man-computer interface, and information requirements for IMIS. A portable maintenance computer will be developed in conjunction with the development of interfaces for airborne and ground-based computer systems. The prototype will be field tested to evaluate the design requirements for integrating and displaying maintenance information.
(David R. Gunning, LRC, AUTOVON 785-2606, 513-255-2606)

AUTOMATED FLIGHT-LINE MAINTENANCE AID
OBJECTIVE: To develop a prototype computer-based graphics and information system for use by maintenance technicians for on-aircraft maintenance—both routine tasks and battle damage assessment.
APPROACH: Hardware and software capable of storing, rapidly retrieving, and presenting both routine maintenance and automated battle damage repair data will be developed. The system will be a small, portable, rugged device capable of handling a variety of procedural, structural, and systems information.
(Capt Stanley Collins, LRC, AUTOVON 785-2606, 513-255-2606)

COMBAT MAINTENANCE CAPABILITY
OBJECTIVE: To develop and test methods by which the Air Force can measure, quantify, and improve its combat maintenance capability. Such methods can be used by Air Force decision makers in determining policies, planning resources for combat, preparing units for combat, conducting operational exercises, enhancing combat logistics and maintenance effectiveness, and influencing the design of more supportable future weapon systems.
APPROACH: A four-phase, ten-task approach is being followed. These phases will critically examine the differences between peacetime and combat maintenance and the effects of these differences on the generation of effective combat sorties. The findings of the phase efforts will be summarized. Suggested changes in maintenance procedures, practices, and organization which appear to have the most

significant impact on effective sortie generation capability will be submitted. Recommendations will be submitted for further study to determine feasibility and cost for incorporating the changes into operating policy.
(Richard E. Weimer, LRC, AUTOVON 785-2606, 513-255-2606)

LOGISTICS ANALYSES FOR THE INTEGRATED COMMUNICATIONS, NAVIGATION, IDENTIFICATION AVIONICS (ICNIA) SYSTEMS
OBJECTIVE: To identify tools and techniques which incorporate logistics engineering parameters into system design during the conceptual phase. These analysis techniques will be demonstrated by applying them to the front-end analysis portion of systems in conceptual design such as ICNIA or the Self-Repairing Flight Control System. Among the unique problems being addressed is the development of analytic reliability and fault tolerance analysis techniques for graceful degradation.
APPROACH: This effort will apply several major tasks to two conceptual ICNIA architectures being developed and the Self-Repairing Flight Control System. The major tasks involve developing front-end analysis techniques in the areas of reliability, maintainability, fault tolerance, life cycle costs, and survivability, and applying them to conceptual designs.
(James McManus, LRL, AUTOVON 986-2018, 513-476-2018)

WARTIME DEMAND RATES FOR AIRCRAFT ELECTRONIC COUNTERMEASURES (ECM) EQUIPMENT
OBJECTIVE: To develop and improve methodology for defining, quantifying, and generating demand rates for aircraft ECM equipment. The products should provide better logistics indicators for improved forecasting of war readiness spares kits (WRSK) requirements in relationship to available dollars and subsequent forecasting of spares requirements computation and capability assessments. This relates to the long-range logistics objective which reads as follows: "Develop a means to better identify and assess logistics requirements and capability, especially as these relate to execution of US contingency plans." The developed methodology will provide information and impact on improved wartime logistics indicators, resource requirements (manpower, WRSK, spares, and support equipment), and aircraft availability in wartime environments.
APPROACH: An ECM "Pilot Study" was accomplished in FY83. The main thrust of the pilot study was geared to four areas: (1) assessing the utility of a two-year study, (2) bounding the problem within workable limits (data base), (3) stating the objectives of the major study, and (4) deciding upon the end product of the ECM study. The ECM study (FY84 and FY85) will be divided into five functional areas: (1) gathering data (combining historical and operational data), (2) identifying solutions and method for selection to include first order test for utility, (3) formalizing selection method, (4) testing selection method and evaluating the methodology, and (5) documenting results of study and translating data into requirements computation and capability assessments. The end product of the study will consist of a "model" used to generate wartime ECM demand rates and a report that translates data into requirements computation and capability assessments.
(Capt Keith A. Briem, LRL, AUTOVON 986-2018, 513-476-2018)

LOGISTICS EXERCISE (LOGEX) PROGRAM
OBJECTIVE: To improve the wartime operational readiness of HQ USAFE logistics command and control personnel by providing them with a microcomputer-based training and exercise system.
APPROACH: Phase I will result in a prototype position-specific (individual) training system to familiarize new job incumbents on their wartime functions in the USAFE/NATO environment. Phase II will expand the system capabilities to include team training on selected critical problem sets and an initial exercise capability. Phase III will involve the completion of the required training modules, the exercise capability, and transition to an operational training system.
(Lawrence S. Finegold, LRG, AUTOVON 785-5910, 513-255-5910)

DEFINITION OF AN ADVANCED ON-THE-JOB TRAINING SYSTEM
OBJECTIVE: To define an improved system for the management and evaluation of Air Force on-the-job training (OJT). The end product was the specification of system functions and hardware recommendations to include the identification of the common and unique tasks for Air Force specialty codes (AFSCs) by position and systematized procedures for training development and performance certification.
APPROACH: This effort concluded the initial step of an advanced development program designed to demonstrate a state-of-the-art training system for Air Force OJT. A planned approach was used to specify the current Air Force on-the-job training system and determine the characteristics required to enhance the relevance of job site training to mission readiness. Subsequent phases included cost studies and the functional specifications required for the system.
(Martin J. Costellic, IDD, AUTOVON 926-4388, 303-370-4388)

ADVANCED ON-THE-JOB TRAINING SYSTEM
OBJECTIVE: To develop, demonstrate, test, and evaluate an Advanced On-the-Job Training System (AOTS) for USAF job site training. AOTS is a large-scale research and development effort to systematically apply state-of-the-art technology to on-the-job training.
APPROACH: AOTS will effect the design and demonstration of five major subsystems addressing the management, evaluation, computer support personnel/logistics support and training development and delivery for job site training. The program evaluates state-of-the-art technology innovations to be introduced incrementally into the OJT program and also plans for the transition of the prototype Air Force wide. The payoff is enhanced relevance of job site training to mission readiness. A full-scale demonstration is planned for a single Air Force base representative of the Air Force mission.
(Martin J. Costellic, IDD, AUTOVON 926-4388, 303-370-4388)

INTERACTIVE GRAPHICS SIMULATOR FOR MAINTENANCE TRAINING
OBJECTIVE: To determine the cost/training effectiveness of a low-cost interactive graphics simulator (IGS) as compared to actual equipment for the F-111 6883 Avionics Test Station.
APPROACH: A low-cost, video-disk/microcomputer-based device was developed and is undergoing evaluation in an avionics course at Lowry Technical Training Center. The evaluation includes both a paper and pencil and a hands-on performance test to determine procedural and troubleshooting skills for those with IGS training compared to those with actual equipment training. Specifications for a stand-alone capability for this simulator will be delivered which will assist planned technology transition to ATC.
(Thomas D. Baxter, IDE, AUTOVON 926-2482, 303-370-2482)

HANDBOOKS AND SPECIFICATIONS FOR MAINTENANCE TRAINING SIMULATORS
OBJECTIVE: To develop introductory handbooks for acquisition managers and instructional system development (ISD) teams involved in requirement, development, design, and procurement of maintenance training equipment.
APPROACH: Three handbooks were developed based on analysis of information concerning the design, fabrication, and life cycle logistics support of maintenance training devices. These handbooks address prime item development, instructional system development, and logistical support considerations. They will be updated based on visits and surveys of maintenance training simulators throughout the military and industry.
(Thomas D. Baxter, IDE, AUTOVON 926-2482, 303-370-2482)

AFIT School of Systems and Logistics

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Project Warrior

Project Warrior is a concept fomulated to create an environment where our people can learn from the warfighting lessons of the past and use that knowledge to better prepare for the future.

Logistics Warrior

Logistics Warrior is the contribution of your journal to help create that environment. Your suggestions are solicited.

LOGISTICS WARRIORS: Fact or Fiction

"The history of 1914-1918 is full of examples. Passchendaele perhaps provides the most striking. It is clear from what Haig said beforehand that his motive was a desire to, and belief that he could, win the war single-handed in 1917 by a British offensive in Flanders before the Americans arrived. By the time he was ready to launch it all the conditions had changed, and the chief French commanders expressed grave doubts. Yet in his eagerness to persuade a reluctant British Cabinet to allow him to fulfill his dream, he disclosed none of the unfavorable facts which were known to him and exaggerated those that seemed favorable. When his offensive was launched on the last day of July, it failed completely on the part that was most vital. Yet he reported to London that the results were 'most satisfactory.' The weather broke that very day and the offensive became bogged.

When the Prime Minister, becoming anxious at the mounting toll of casualties, went over to Flanders, Haig argued that the poor physique of the prisoners then being taken was proof that his offensive was reducing the German Army to exhaustion. When the Prime Minister asked to see one of the prisoner's cages, one of Haig's staff telephoned in advance to give instructions that 'all able-bodied prisoners were to be removed from the corps cages' before his arrival. The chain of deception continued, and the offensive went on until 400,000 men had been sacrificed.

In later years Haig was wont to argue in excuse that his offensive had been undertaken at the behest of the French and that 'the possibility of the French Army breaking up compelled me to go on attacking.' But in his letters at the time, since revealed, he declared that its morale was 'excellent.' And the following spring he blamed the Government when his own army, thus brought to the verge of physical and moral exhaustion, failed to withstand the German offensive."

From: *Why Don't We Learn From History?* by B. H. Liddell Hart.

LOGISTICS WARRIORS: Korea - Supply

"Three separate and parallel supply systems functioned during the Korean War. The principal one naturally was that of the United States since it provided the bulk of the clothing, rations, equipment and weapons used by all US and attached UN units except those of the British Commonwealth. The British maintained a separate supply line, while the ROK forces maintained their own, with both allies receiving a portion of their supplies from US sources.

Thus, a principle of providing supplies on a reimbursable basis became the underpinning for allied logistics. It required EUSAK to establish a method of materiel supply, maintenance of records and a system of accountability so that the US government could later request reimbursement based upon adequate and accurate information. But, in addition to the reimbursement question, problem areas of importance also included clothing, dietary needs, vehicular and weapons maintenance and medical evacuation."

From: "Allied Interoperability in the Korean War," *Military Review* (Jun 83) by B. Franklin Cooling.

LOGISTICS WARRIORS: Falklands Logistics

"But all of this—ASW operations, amphibious operations, and air operations—is overlaid throughout this campaign by the dominant role played by logistics. Operating 8,000 miles from home, bringing everything essentially 'on their backs,' having only one en route base (one which was not designed for combat support of a fleet at sea), the British nevertheless succeeded mainly because their logistics system outmatched that of the Argentines at every point. When it became clear that one brigade was not going to be enough against a determined British effort, the Argentine logistic system could not cope with a need to supply a second brigade, *even though one was sent to the islands*. In contrast, the British accepted losses of planes and equipment in combat, endured heavy sea conditions, suffered predictable wear and tear and utilization rates of material, and yet were able to crank-up and then sustain their logistics effort for as long as it took to do the job. Argentine weapons that worked did so with some devastating results. But British weapons worked more often. Maintenance, support, know-how, and morale, all played a major part in the ultimate British success. And controlling all of that was a command system that allowed the sort of rapid, flexible decision-making needed to bring the right combination of forces to bear at the right place and time."

From: "When Deterrence Fails: The Nasty Little War for the Falkland Islands," *Naval War College Review* (Mar-Apr 83) by Cdr Kenneth R. McGruther, USN.

LOGISTICS WARRIORS: Falklands Success

"In conclusion there are eight reasons why the British were successful in this case, and in large part these will be keys to victory in any military endeavor. The first was the naval power they were able to bring to bear, allowing them political as well as military options. Second was their firm adherence to clear direct objectives. There was no 'turning of the screws,' no incremental creep of what would constitute a satisfactory conclusion once military success became apparent. And towards that objective there was going to be a political solution or there was going to be a military solution, but, whichever, it was going to be a clear solution. Third, there were clear orders given throughout from the political leadership to the military authorities. 'Man and support the fleet.' 'Send the force.' 'Retake the Falkland Islands.' Within these clear orders the commander on the scene could plan and execute his operations. The fourth reason was speed: speed of political decisions once the need was clear; speed of military operations once the political order had been given; speed of execution once the military orders had been given. Fifth was mobility, both afloat and ashore. This provided flexible options which allowed British strategy to continue to evolve as the operation progressed, taking always the best course, always the proper sequence. Logistics and training have already been mentioned, but warrant mention again. Finally there was the sheer willingness of the British to take risks. That is a necessary part of war."

From: "When Deterrence Fails: The Nasty Little War for the Falkland Islands," *Naval War College Review* (Mar-Apr 83) by Cdr Kenneth R. McGruther, USN.

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Security Assistance in Peace and War

History is often used to support both the argument that arms sales during peacetime leads to conflict and the view that wars are deterred by arms balances among adversaries. Whatever the view of security assistance during peacetime, there is ample evidence to show that security assistance has and can effectively support national strategy in time of war. Examples from World War II, Korea and Vietnam suffice to identify major wartime functions of security assistance; e.g., stabilizing important regions; fostering military to military relationships; maintaining open communications and supply lines in and between theaters; providing for economy of force operations with concomitant massing of American combat power at points of decision; and acting in some cases as force multipliers. The impact of wartime security assistance on industrial base preparedness requires considerable forethought if the objectives are to be obtained as does the relationship of aid programs to policies for war termination and the post-war recovery.

Current administration policy guidelines and objectives are now integrating security assistance planning into long-range strategic planning. These plans not only address current foreign policy goals, but specifically emphasize both conflict deterrence as well as many of the functions that security assistance could perform in time of war.

To employ security assistance effectively during wartime, more attention must be given to transition to war planning. Some current mechanisms, such as the US Army Standard Support System for Foreign Armed Forces, could be adapted to wartime security assistance requirements. The procedures for the stocking of defense articles, and the policies of coordination, funding, transportation and theater implementation of security assistance are currently unresolved issues requiring immediate attention if a wartime program is to succeed.

Other current issues that must be resolved include: regional and country specific priorities; arms standardization problems; requirements for preparation of the US defense base; diversions from existing stocks; technology transfer; and the supplier/customer relationship. In short, the US has not devoted sufficient effort or assets to plan for the employment of security assistance during coalition warfare. It is time to begin, and the history of past US involvements in wartime assistance to allies provide an excellent point of departure.

Quoted from Strategic Studies Institute Special Report (ACN 83018), US Army War College, Carlisle Barracks, Pennsylvania